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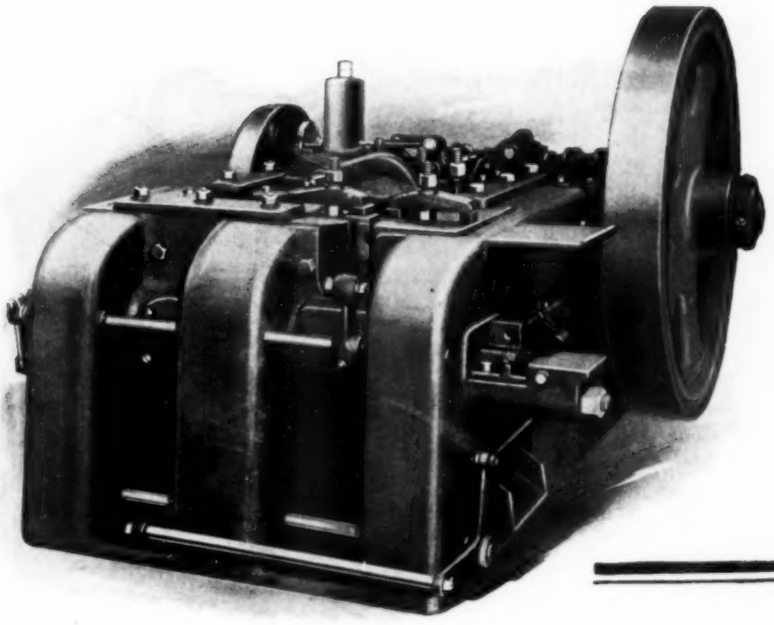

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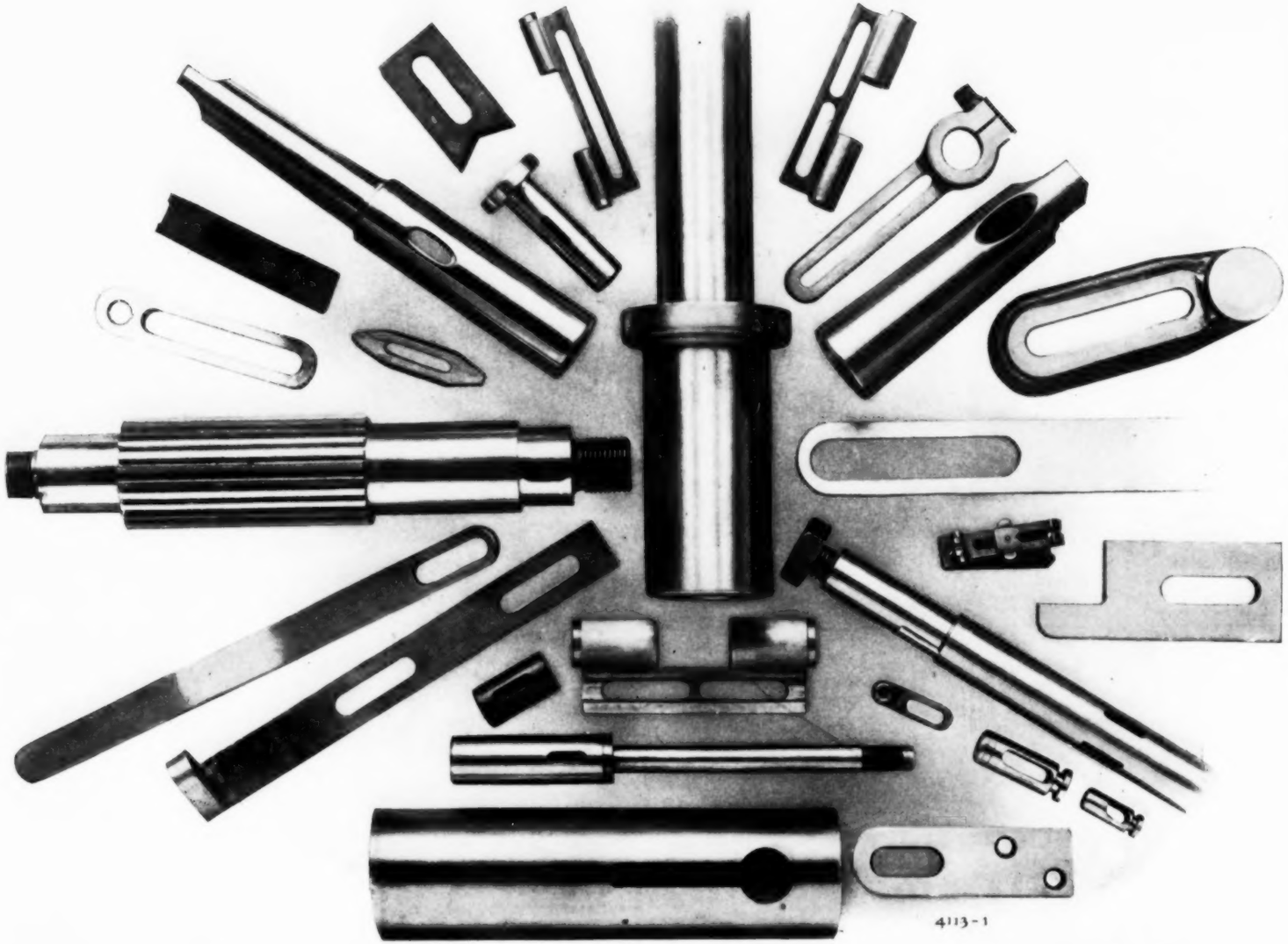
A few specimen slots, splines, grooves and key-ways cut on the P. & W. Spline Miller that show the adaptability of this machine in the manufacture of machine parts.



The P. & W. Spline Miller

The Borsig Locomotive Shops

By V. Litz*

The use of the autogenous torch in cutting out plate locomotive frames and the machines used to straighten, slot, drill and mill the plates in packs.

Riveting and alining the boilers; the method of making the driving-box housings or pedestals for the plate frames.

Interesting features of shop construction and special machines, feeds and speeds in milling.

The first locomotive built in Germany was constructed in the year 1841 by A. Borsig for the Berlin-Anhalt railway. By 1870, 30 years after, nearly 3000 locomotives had been built, although the shops were, according to present ideas, equipped in a very primitive way.

The works, which up to the end of the nineteenth century were situated in the heart of Berlin, became inadequate and from urgent necessity the new shops of the firm were established in Tegel, a suburb of Berlin, along the most modern lines.

Locomotive construction, which has always been the principal work of the Borsig firm, remains its chief line of manufacture in the new plant. Since their beginning the new shops have turned out more than 3000 locomotives, and with the present yearly production of 500 to 600 engines, the total output of the firm since the start has rapidly grown to 8000. It is, therefore, of interest to take a brief survey of the shops, examining some of their methods of work, machinery and appliances. Only a few operations have been selected, which will show the systematic methods of work and the tendency to substitute machine for hand work, to secure interchangeable parts.

An important part of the locomotive is the frame. According to the most common European practice it consists primarily of two rectangular side plates, rolled out of the ingot of steel to the size required. In machining this sheet a plate templet of the finished piece is first made from the construction drawings and not a special frame-templet drawing. This thin plate templet is used in the layout for cutting out the frame plates, as well as to mark the screw and rivet holes; then the several frame plates are cut out with autogenous cutting appliances. Plates up to 250 millimeters (9.85 inches) thick can be cut out with such a machine.

*Engineer, A. Borsig.

This process is clearly shown in Fig. 2. The burner construction is that of the chemical factory Griesheim Elektron, in Frankfort-on-Main. The autogenous cutting out of plates 20 millimeters (0.7874 inch) thick, for example, requires, say, about 10 minutes, consuming 110 liters (3.88 cubic feet) of hydrogen and 300 liters (10.59 cubic feet) of oxygen.

It will be noted that the cutting nozzle of the torch is supported by a pair of small wheels which enable the operator to roll it along easily and steadily. In cutting out openings, it is necessary to punch or drill a small hole as a starting point.

In cutting out, the plate is bent and it has to be straightened, which is done upon the plate-straightening machine shown in Fig. 2. This machine has altogether seven rolls for straightening out the plates. It will take a plate up to 1800 millimeters (70.86 inches) wide and 5 to 35 millimeters (0.196 to 1.378 inches) thick. It is electrically driven.

After cutting out and straightening the individual sheet, it is packed and clamped together with several others for milling on the outside and cut-out edges. Fig. 3 shows a triple-frame milling and slotting machine with three cutting heads each driven by an individual motor. This machine will take plates up to 10,500 millimeters (34½ feet) long and 1900 millimeters (74.8 inches) broad in packs up to 220 millimeters (8.7 inches) high, using three cutters at the same time.

Fig. 3 also shows the arched-roof construction which is not common in the United States, and the crane runway, practically an independent structure from the building itself.

High-speed steel milling cutters of 100 millimeters (3.94 inches) diameter are in use. For a pack 220 millimeters (8.7 inches) high, the feed is 15 to 18 millimeters (0.59 to 0.70 inch) per minute with 15 millimeters (0.59 inch) cut.

From the milling machine the pack is taken to the drilling machine where the requisite screw and rivet holes are drilled as already laid out with the plate templet.

In Fig. 4 is a triple drilling machine which is also equipped with three heads and a motor for each. The housings will take a width of 1700 millimeters (66.9 inches) and the bed length of the entire machine is 9000 millimeters (29½ feet). This machine drills holes to 380 millimeters (14.9 inches) deep and 100 millimeters (3.94 inches) diameter with a

FIG. 1. CUTTING OUT FRAME PLATES WITH TORCH

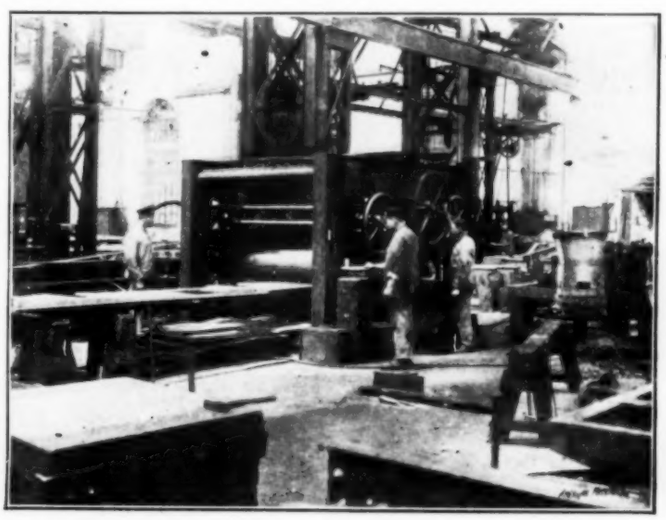


FIG. 2. STRAIGHTENING THE FRAME PLATES

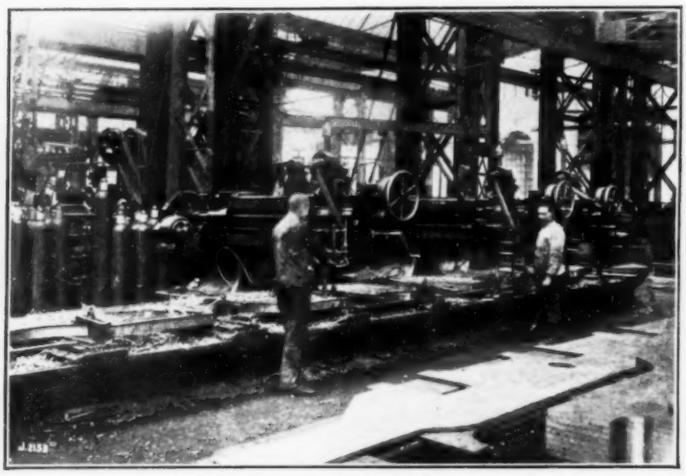


FIG. 4. DRILLING THE FRAME PLATES

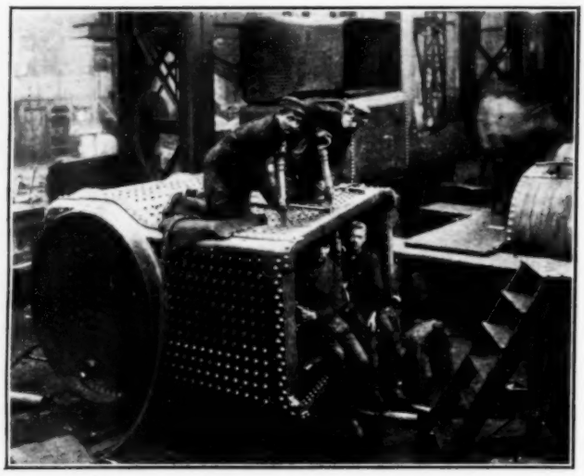


FIG. 5. RIVETING THE FIREBOX

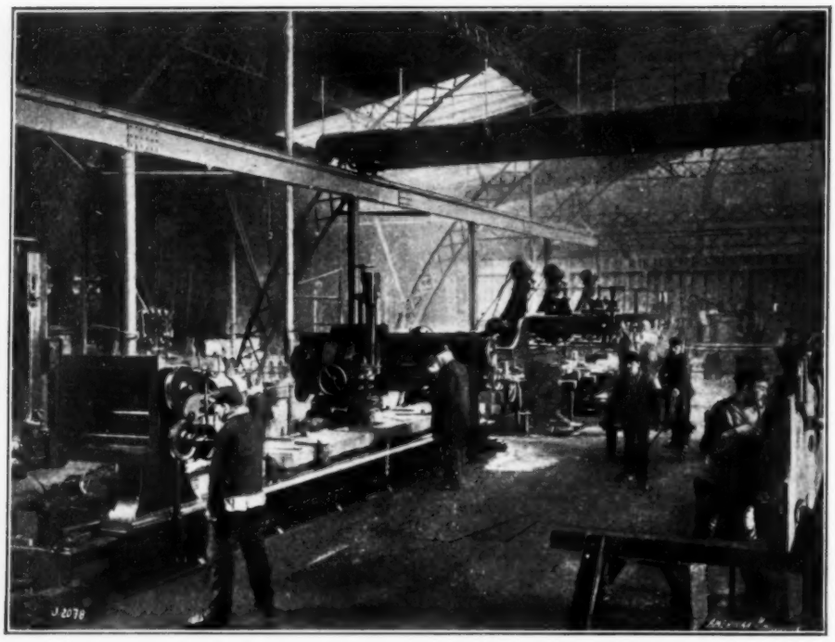


FIG. 3. SLOTTING THE FRAME PLATES

drill speed of 115 revolutions per minute.

With these operations the machining of the frame-plate edges is completed, and the plates necessary for assembling the complete frame with the necessary cross-braces, brackets, etc., have been prepared.

The laying out, cutting out, straightening, milling and drilling of the frame plates for a C 1 tender locomotive of about 50 tons weight empty, and about 65 tons working weight—that is, the entire work upon the frame side plates of such an engine up to the delivery of the plate for the assembling—requires a time of about seven days. Such a plate is 9200 millimeters (30 feet) long, 1200 millimeters (47¼ inches) high and 15 millimeters (0.59 inch) thick. When taking in hand at the same time about 25 or 30 similar frames, there is required for machining a complete frame in the above described multiple manner, including also the erection and assemblage with all other parts, such as cross connections and brackets, up to the putting of the

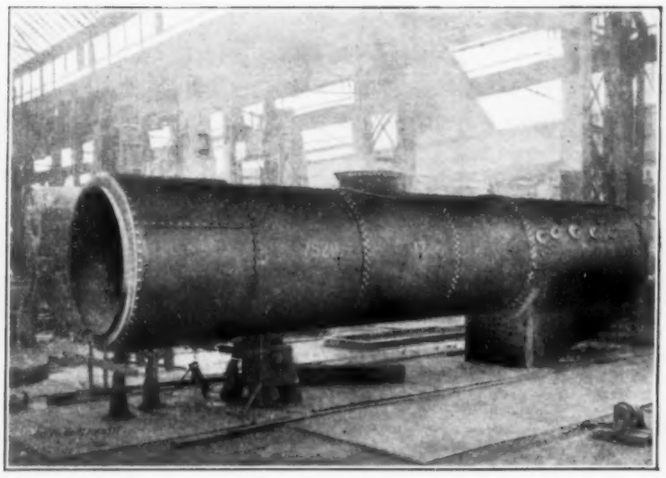


FIG. 6. TESTING ALINEMENT OF BOILER

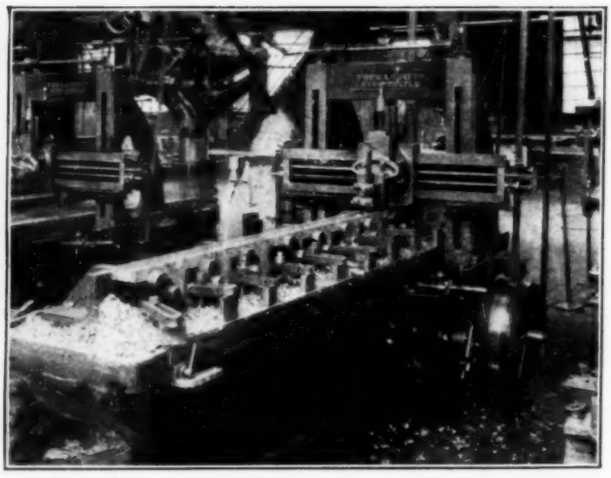


FIG. 7. PLANING DRIVING-BOX HOUSINGS OR PEDESTALS

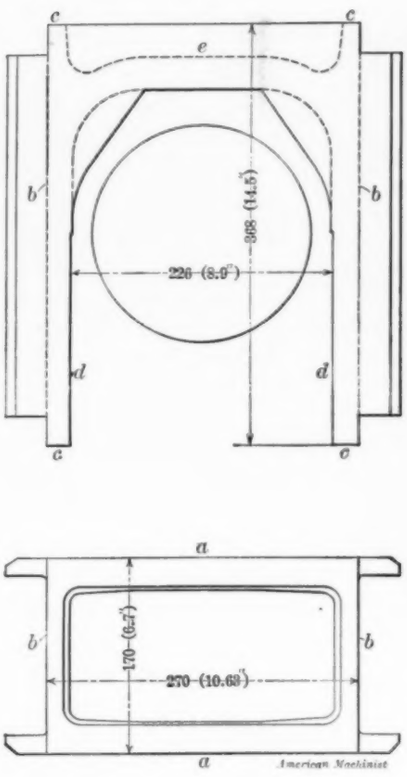


FIG. 8. DETAILS OF DRIVING-BOX HOUSING OR PEDESTAL

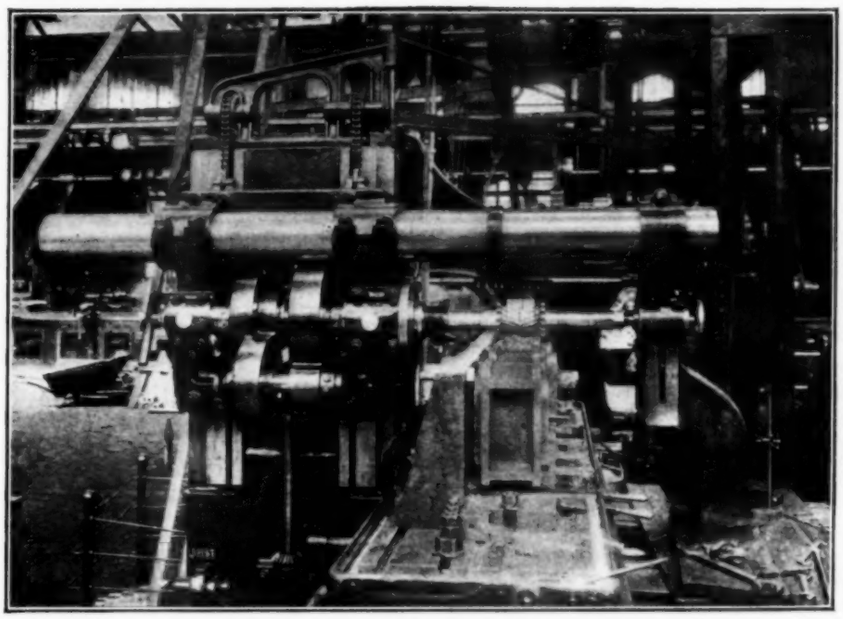


FIG. 9. MILLING DRIVING-BOX HOUSINGS

boiler on the frame and mounting the cylinder, a period of about three weeks.

Fig. 5 shows a nearly completed firebox. The staybolts connecting the inner and outer sheets are threaded their whole length or only at the ends, as the case may be. The sheets are tapped by pneumatic drilling machines. The ends of the bolts are afterward riveted with a pneumatic hammer. With such a pneumatic tool about 40 staybolts per hour can be riveted, according to the softness of the material.

The completed firebox is then joined to the longitudinal shell and then the whole boiler, with all its principal parts, is loosely fastened together as in Fig. 6. This shows the final riveting; the boiler is accurately alined and tested, in order to obviate any work after the final riveting. The boiler is mounted on the frame, and installation of the other locomotive parts begins.

Beside the larger parts of a locomotive, frame and boiler, come the smaller details whose interchangeability plays a prominent rôle and is specially significant. It is highly desirable that locomotive parts subject to constant wear be interchangeable. This enables an important saving through permitting users to carry a smaller reserve stock, entirely apart from the fact that, when necessary, a fitting can be taken from one locomotive and put on another of the same type. As an example, is chosen only the machining of the journal-box housing (or pedestal), as in Fig. 7. These housings, which are made of cast steel, must be machined all over up to the oil chamber *e*, which is left rough. They are first, without previous laying out, faced off on the sides *a* in a planer in order to give a surface as a base for the various operations following. Then a lot of 8 or 10 pieces are simultaneously planed on the opposite side.

In a similar manner the machining of the lateral guides *b* is performed. In preparing for this operation a lot of pieces are clamped in a row against long cast-iron angle irons or prisms and machined as shown in Fig. 8.

The rough-planed pieces are then taken to the milling machine and there finished with a gang cutter. Fig. 9 shows, for example, the finishing work on the rough-planed lateral guides, in which op-

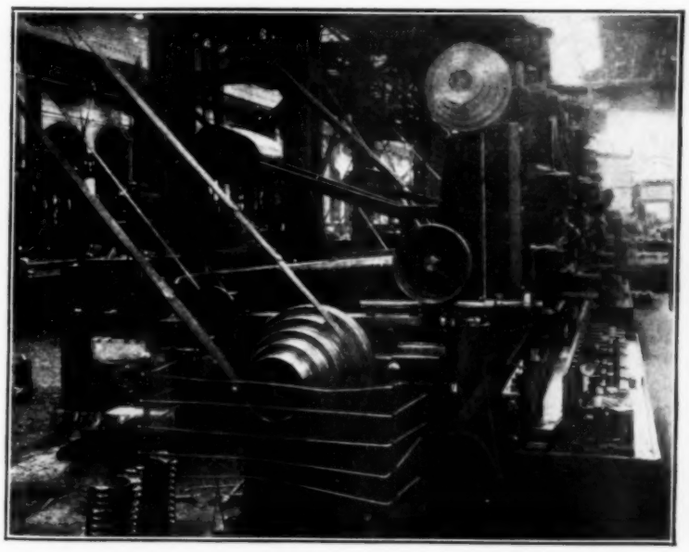


FIG. 10. MILLING OUT DRIVING-BOX HOUSINGS

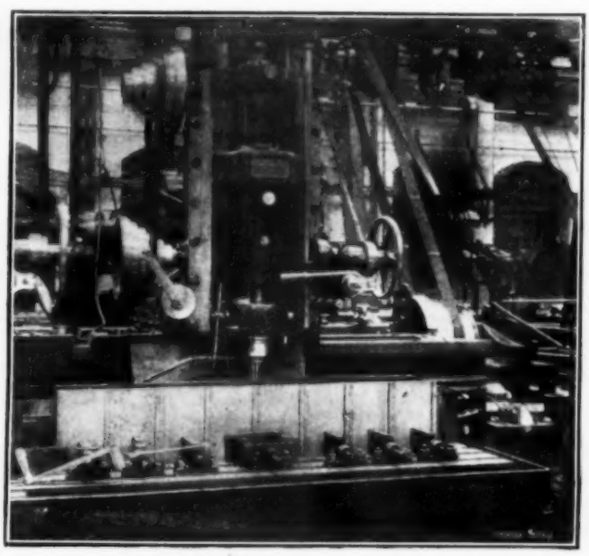


FIG. 11. USING THE END MILL

eration the finishing is performed with a form cutter in a single cut. Previous laying out is unnecessary for the operations that have been mentioned. The workman needs only a steel measure or a simple plate gage.

An accurate plate templet is first used to scribe for the inside work on the faces *d* on the two end pieces.

Milling out the inner surfaces is done in multiple upon a special machine shown in Fig. 10. There are first used upon the inside surfaces the cutters which complete the interior at a single cut. In order to produce the upper corner shape of the inside surfaces, a special formed cutter is used on the same machine which completes inside machining with a single cut right and left. Without clamping the work, the slabbing cutter is replaced on the same machine by an ordinary end mill, as shown in Fig. 11, which first machines the upper faces *c* and after reversal of the work the lower faces *c*.

The cutters on this machine are 80 to 100 millimeters (3.15 to 3.94 inches) in diameter, and work at a cutting speed of 8 meters (26½ feet) per minute.

The chucking and complete machining of 10 such housings with dimensions as given in Fig. 7, for the C 1 tender locomotive mentioned in this article, up to completion of the detail operations and readiness of the pieces for fitting in due course as outlined, require a working time of about 90 hours.

Boring Holes in Hopper Rings

By Albert E. White

Combining a 30-inch drill press with a 10x16-foot extension mill for drilling and counterboring 172 1⅜-inch holes in a flange of a hopper ring that was beveled at an angle of 40 degrees, the holes being in two circles and staggered.

Rather a novel way of boring beveled holes in the hopper ring of a blast furnace has been adopted at one of the machine shops of the Pittsburg district. The last ring bored had three flanges. It was 15 feet 10 inches in diameter, 23 inches high, 2½ inches thick, and weighed 17,200 pounds. It had to be machined all over, and spot faced on the back. On two of the flanges there were 56 holes, respectively, but as these flanges lay in a horizontal plane there was no difficulty encountered in doing this work on a Prentice 6-foot semi-radial drill press. The machining and spot facing was readily done on a 10x 16-foot Betts extension boring mill.

Difficulty was met with, however, when it came to boring the holes of the upper flange. There were 172 1⅜-inch holes to be bored in this flange, arranged in two circles, each one of which had 86 holes. The trouble came from the fact that the flange extended out from the main body of the work at an angle of 40 degrees and the holes to be bored had to be at right-angles to the flange.

It was possible to do this work on a Prentice 6-foot semi-radial drill press, but by so doing it would necessitate the constant use of the shop's electric traveling crane until the completion of the work, and thus practically the whole shop would be tied up. Two hours would be consumed in originally setting up the casting, 15 minutes in moving the casting when changing holes and 10 minutes in boring each hole. One man and two helpers would be required to do the work and, consequently, a total of 73⅓ hours would be consumed.

The main objection, however, to the standard method of doing this work was due to the fact that the holes could not be accurately bored; that no matter how careful the workmen might be, it was practically impossible to bore all of these holes true.

A Barnes 30-inch upright drill press was set up over a 10x16-foot Betts extension mill and by the combined operation of these two machines all the objections detailed above were overcome. The manner in which the machines were set up and the way in which the boring was done is shown in Figs. 1 and 2.

The shop was not tied up because of the loss of the use of the crane. The time consumed in boring the holes was reduced from 73⅓ hours to 41½ hours, as the casting was moved from hole to hole in less than a minute, and this, according to the previous method, would have consumed about 15 minutes. But best and most important of all was the fact that each and every hole was bored at right-angles to the flange, and was absolutely true and in correct alinement to the rest.

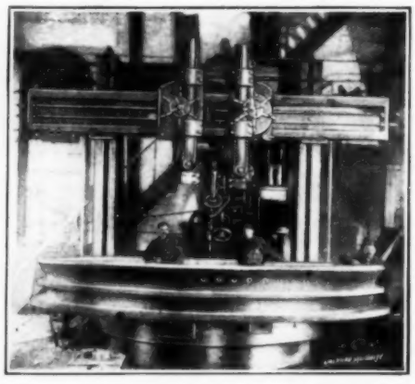


FIG. 1. DRILL PRESS SET UP ON BORING MILL

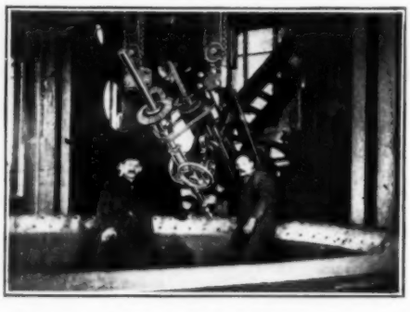


FIG. 2. OPERATING COMBINED DRILL PRESS AND BORING MILL

Indifference Loses Trade

Writing in regard to the indifference of certain American manufacturers to possible markets for their goods in Siberia, Consul Lester Maynard, of Vladivostok, says:

There is undoubtedly a large field in eastern Siberia for mining and logging machinery, such as is manufactured in America, but it is likewise certain that a serious effort must be made to get the business; it is the indifference of certain American firms that enables competitors to capture the market. Firms like the International Harvester Company, realizing that their product is superior, although in many cases more expensive than similar articles manufactured in European Russia and other countries of Europe, have clearly shown that they can successfully compete, due to the fact that they enter the foreign field, demonstrate with their machines when necessary, establish central supply stations, place competent and energetic men in charge of their offices, extend credits with good security to protect them, follow up possibilities of new business, and, in fact, make every possible and reasonable effort to introduce their goods. It is unfortunate that other large concerns should show so much apathy and indifference, as a serious effort on their part would reap a rich reward.

A representative of the Moline Plow Company will soon be in Vladivostok on a tour of this district, and I have no doubt the company will make the necessary serious effort to introduce its plows into eastern Siberia. I feel sure of its success, as would be the case with other large concerns making an article that is in demand here, if they put forth the proper effort.—*Consular Report.*

The Predecessors of Watt's Engine

By H. W. Dickinson

A birdseye view of the toilsome progress of invention two centuries ago.

Most educated persons and probably very many engineers would, if asked who James Watt was, reply at once that he was the inventor of the steam engine, and while this is in a sense the truth, it is not the whole truth, because Watt commenced as the improver of an existing apparatus—to wit, the atmospheric engine of Thomas Newcomen.

In this article I propose to give the salient points in the history of this remarkable engine, which did yeoman service for more than 50 years, and leave the subject at the stage when Watt's attention was drawn to it and when he began his improvements.

The genesis of an invention is always interesting, but of this, the most momentous discovery of its age and the ultimate source of the material progress of the last two centuries, it must be regretfully owned that very little is known. All that can with certainty be said is that in 1719 or 1712 the Newcomen engine was in actual operation.

The Work of Papin and Savery

For quite 50 years, scientific and practical men, notable among them Denis Papin and Thomas Savery, had been engaged in trying to turn to practical account the discovery of Evangelista Torricelli that the atmosphere had weight, a fact that he had deduced from his observations of the hight that mercury will stand in a barometer tube. Then was given for the first time the true reason why water follows the bucket of a suction pump. It was not a great step from this to imagine that if one could remove the pressure of the atmosphere from under the bucket, the pressure of the air on the upper side would force the bucket down and, by attaching a cord to the bucket, lift a weight.

Papin got so far in 1690 as to scheme a closed vessel or cylinder with a piston, in which was a nonreturn valve, as shown in Fig. 1. A little water on the bottom of the cylinder was boiled and when the steam had forced out the air through this valve, and when the cylinder had cooled again, the piston would descend when the catch was released. But he was unable to devise means for repeating the motion even had it not been altogether too slow.

Savery went on another track. His apparatus had a boiler with a hand-controlled valve admitting steam to a receiver provided with foot and head valves. By external condensation of the steam by a stream of water outside, he could draw water from a depth of about 20 feet, and then shutting off the condensing water force it to a hight depending on the steam pressure, all as shown in Fig. 2. The necessity for this pressure was a fatal defect in the then state of the mechanic arts, for no means of construction which would stand more than a very moderate pressure were known; it had to be a plumber's job, in fact. However, Savery managed in 1698 to get a patent for 14 years for his engine; indeed, it was a master patent, so widely was it worded: that is, "for raising of water and occasioning motion to all sort of millworks by the impellent force of fire." He was granted a prolongation of his patent for 21 years, making 35 in all, so that it did not expire till 1733. The invention, for the reason given, met with but scant success. The curious in these matters will notice that this apparatus is practically identical in principle with that brought out in 1872 by Cyrus H. Hall, and known as the pulsometer.

The Newcomen Engine

And now Newcomen comes on the scene, for we are assured by a contemporary writer that: "Mr. Newcomen was as early in his invention as Mr. Savery was in his," but the latter being nearer to the court obtained a patent first. Newcomen's invention was totally different from Savery's, yet the latter's claim fully covered it, and this accounts for the fact that Newcomen never did get a patent, repeated statements to the contrary notwithstanding. The writer already quoted says that Newcomen was glad to come in as a partner of Savery. For about 12 years, therefore, Newcomen, who was an ironmonger, assisted by John Cawley or Calley, a glazier, was perfecting the invention at his home in Dartmouth, Devon.

In its essentials the plant, shown in Fig. 3, consisted of a boiler, after the style of a brewing copper, above

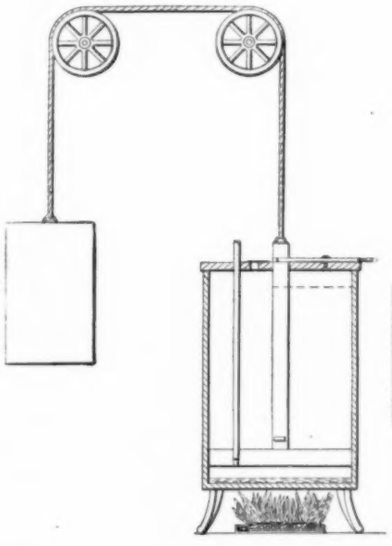


Fig. 1. Denis Papin's Engine—1690

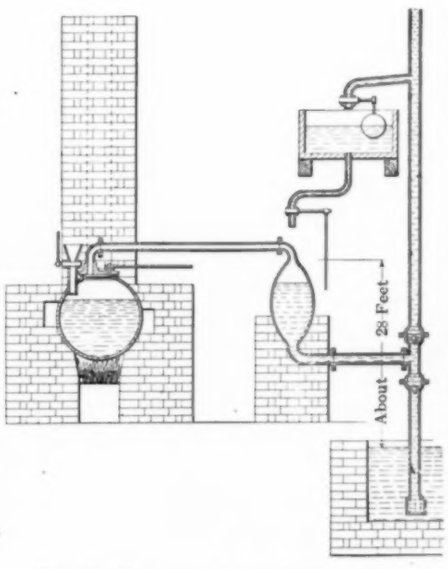


Fig. 2. Thomas Savery's Engine—1698

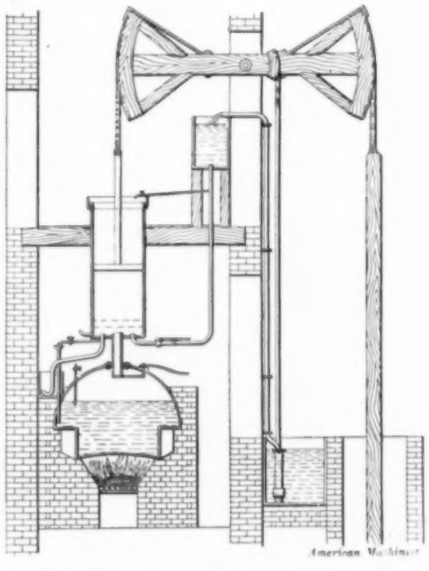


Fig. 3. Newcomen's Engine—1712

which was a thin brass cylinder provided with a piston attached by a chain to one end of a beam or gigantic pump handle, from the other end of which hung the buckets and pump rods that balanced the piston. Steam just above atmospheric pressure was introduced into the cylinder, and when the piston had got nearly to the top of its stroke a jet of water was turned on inside the cylinder, the steam was condensed and the atmosphere forced down the piston, thus raising the pump bucket. The grand feature of this invention was that no matter from what depth water was to be raised, steam at atmospheric pressure only was required.

So far this was a combination of known elements, but success would not have resulted from it without two other beautiful and original inventions. The first was a valve gear which opened and shut the steam and injection valves at the right moments; the second was a "snifting" valve whereby the injection water and the condensed steam, together with the small amount of entrained air, were removed from the cylinder. This valve gear was the first invention in the world's history by which a nonliving agent had been schemed to repeat its own operations automatically an indefinite number of times—in its results surely a most pregnant discovery. Nevertheless, it seems to have excited the attention of the scientific men of the day very little.

From contemporary prints and published notices we are able to piece together with some show of probability the subsequent career of this invention. The earliest known representation of the engine is an engraving, dated 1719, of an engine erected in 1712. It is not quite certain, however, that the engine shown was the first to be erected, because proposals were made in 1710-1711 to put down an engine at Griff, in Warwickshire. Even if not at once acted upon, they were soon after, because an engine was in existence at Griff a few years later. Difficulties were encountered in the construction and working of these pioneer engines, but these were overcome by skilled mechanics from Birmingham.

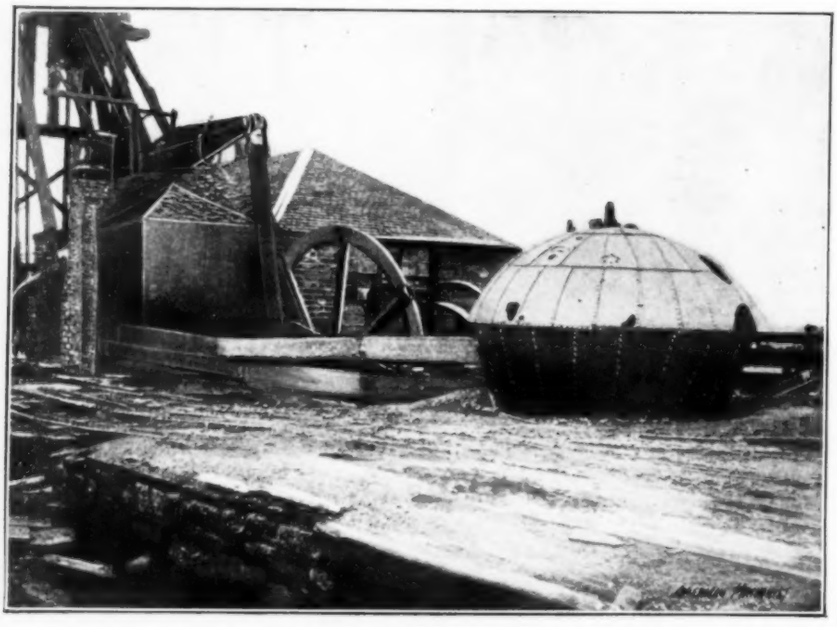


FIG. 4. A NEWCOMEN ENGINE THAT IS STILL DOING DUTY

THE HUMPHREY POTTER STORY A MYTH

It is said that Newcomen at first condensed like Savery, by water on the outside, and that the jet was only found out by the accident of a leaky piston. To understand this it should be remarked that water was used on the top of the piston as packing—another ingenious idea.

We are assured by Dr. J. T. Desaguliers in his "Experimental Philosophy" that the self-acting valve gear was schemed by a boy named Humphrey Potter because he wanted to be released from turning the cocks by hand so he could go and play—a most improbable tale. Several individuals of the name of Potter appear in connection with the Newcomen engine during the subsequent 15 years of its existence; indeed one went as far afield as Königsberg, in Hungary, to erect an engine, and was there believed to be the inventor of it. No doubt one of these engineers added an improvement, and hence the story.

The snifting valve was a neat way of overcoming "wind logging." From the bottom of the cylinder an eduction pipe led to a cistern of water where the end was closed by a poppet valve. When steam entered the cylinder the condensed water ran out by gravity and the air followed through this valve, giving rise to the noise which gave it its name.

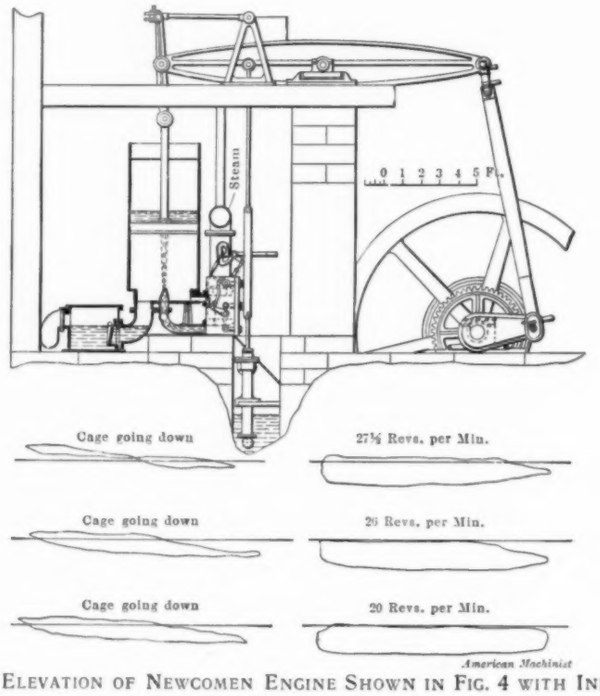


FIG. 5. ELEVATION OF NEWCOMEN ENGINE SHOWN IN FIG. 4 WITH INDICATOR CARDS TAKEN JUNE 20, 1901

SIZE AND COST OF THE OLD ENGINES

A rough idea may be formed of the space necessary at this period to develop a given power when it is noticed that the

engine shown in the above mentioned engraving had a cylinder 21 inches in diameter by 7 feet stroke and from the quantity of water raised was of 5½ effective horsepower. The cost, too, was enormous. For an engine not much larger than this, built in 1725 in Scotland, the cylinder alone cost £250, and the total expense, excluding the engine house and pit work, exceeded £1000. As this must be multiplied by 3 or 4 to obtain the value at the present day, it will be seen that it was no light undertaking to erect an engine in the year of grace 1725. The engine met a long-felt want, so that, notwithstanding all this, it was adopted at colleries up and down the country, to such an extent that when the celebrated engineer John Smeaton turned his attention to the subject he found, in 1769, no less than 57 engines, one with a cylinder as large as 75 inches diameter, in use in the Newcastle district alone. The average duty of these engines was 5.6 millions of pounds of water raised 1 foot high by the expenditure of 1 bushel (84 pounds) of coal. By judicious proportion and better workmanship Smeaton obtained a duty of 9½ millions. The most celebrated engine of his construction was that at Chacewater in Cornwall, completed in 1775. By that time, however, Watt, in partnership with Boulton, had begun the construction of his improved engine and as it would "fork" as much water as the atmospheric engine with about one-third of the consumption of fuel, the doom of the latter was sealed.

It did not go under without a struggle for, at the pit mouth where coal is cheap, these engines long survived. Indeed one is actually at work at the present day at a colliery near Rutherglen in Scotland, and shown in Figs. 4 and 5, for the latter of which I am indebted to the *Proceedings* of the Institution of Mechanical Engineers. It is a rotative engine and from the illustrations it will be noticed that the wooden beam has been replaced by one of iron, and the flexible connection to the piston by a piston rod and parallel motion. As one would expect, the beam was the weakest part of the engine.

The long life of these veterans is in marked contrast to the engines of today, which find their way to the scrap heap before they have had a chance to become venerable.

Some Shops in Cologne

Editorial Correspondence

Visits to Alfred H. Schutte, the shops of the Rhenania and the Deutz works.

Interesting gear hobbers, milling machines, gasolene, benzol and other internal combustion motors.

A modern shop for heavy tools such as presses, shears and cranes used in structural steel work.

Our first objective point in Cöln (or Cologne) was the office and show rooms of Alfred H. Schütte. These are the main offices of the firm, splendidly fitted up in a group of buildings on one of the principal thoroughfares. The show rooms are divided in sections, each for a distinct type of machine or product. In the basement is a demonstration machine shop where any machine tool can be put under belt at once to demonstrate its capabilities to a prospective customer. Anyone acquainted with American machine tools would feel at home under such surroundings.

An interesting office room was the one where catalogs are translated. And here it is not only necessary to see that an accurate translation be made, but it is likewise necessary to know that the data printed are accurate. For instance, if a German catalog states that the return ratio of a planer is 1 to 3, it is essential that it is 1 to 3 and not something else.

Maschinenfabrik Rhenania

Just outside of the fortified wall that surrounds Coln is the Maschinenfabrik Rhenania, notable for high-class gear cutting.

The shop buildings are new, with excellent overhead light and have a finely equipped suite of offices. Here gears of all sizes are cut and hobbing and thread-milling machines built. An interesting job was noticed in milling bevel-gear blanks with a formed cutter in a gear hobber—a circular milling operation.

Across the Rhein is the large plant of Gasmotorenfabrik Deutz.

In passing it is of interest to mention that a new bridge is under construction over the Rhein, being built around the old bridge. As a section of the new bridge is completed the steelwork of the old bridge is cut away with the oxygen-hydrogen blowpipe, and the pieces are lowered to boats waiting in the river below for transporting away.

Gasmotorenfabrik Deutz

We were shown over the Gasmotorenfabrik by the chief engineer. Small gas engines, Diesel oil engines and kerosene engines are the principal output. Here in 1902 the first large size four-cycle, double-acting gas engine was developed. It is still to be seen in the shop power station, and is run as occasion demands.

An interesting type of engine is a six-cylinder benzol engine, 100 horsepower rating, used as an isolated plant for driving a passenger coach. The use being to run the coach by its own power over a short branch line or from a small station to an important one where the coach can be cut into a regular steam train.

Manufacturing operations are highly developed. A special machine was noted for boring the cylinder, main bearings and cam-shaft bearings, simultaneously, of gas-engine frames. Universal work holders or vises, system Sulzer, are much used and apparently to excellent advantage. By their use a frame for a small gas engine, or a cylinder for a larger size, or a crank shaft, can be set up under a drilling machine and all of the drilling and boring done at a single setting. The holders are truly universal so that a hole can be drilled at any place and at any angle by merely swinging the piece into position by the movements of the parts of the holder. The larger sizes of these holders are motor operated.

Haniel and Lueg

Some 2000 men are employed in these works, which are divided into machine shops, iron foundry, hydraulic-forging plant, steel works, forge and hammer works and cast-pipe foundry.

A large variety of heavy machines is made: Large gas engines, steam-hydraulic forging presses, centrifugal pumps, hydraulic riveters, steam engines, blowing engines, rolling mills, etc. Besides there is a large business in iron and steel castings and cast pipe.

A walk through the plant showed a most interesting pipe foundry, with several pits, and an adjacent finishing shop.

In the iron foundry were several molds for large turbine castings in various stages of completion. The molds are either baked in ovens, or are skin-dried by air blown through coke-fired stoves.

In the steel foundry an immense crosshead for a 10,000-ton forging press was just being cleaned. Another shop held the rods for this press, which will be the largest of the type ever made by the firm.

The machine shops showed a great deal of heavy work in process, gas-engine shafts, turbine cylinders, hydraulic-press rods, a steamship rudder post and a 4000-horsepower engine connecting rod, the latter cut out of a solid forging.

Bechman & Keetman

Perhaps the most modern machine

shop in the vicinity of Düsseldorf is that of Bechman & Keetman, at Duisburg. The product is heavy tools, such as presses, shears, cranes and structural-steel work. The buildings are very attractive in design, light, sanitary and up to date.

In the shop some very large cut-steel pinions were noticed; one about 74 inches in diameter, 60-inch face, 7 inches circular pitch, with staggered teeth.

Among the modern machine tools in the equipment was seen a slotter with a reversing motor and a very large planer, also fitted with a reversing motor.

Some 1500 men are employed and 60 to 70 apprentices. The firm has set apart one floor of the building, directly connected with one of the machine shops, for school purposes and members of the engineering staff act as teachers. Here the apprentices are required to go to school a certain number of hours per week.

ERNST SCHIESS-WERKZEUG-MASCHINEN-FABRIK A. G.

One always thinks of the firm of Ernst Schiess as the builder of very large machine tools. This impression was hightened when we walked into the machine shop of this firm and saw a huge lathe headstock casting slung up by two cranes and being wenghed. The weight was 40,000 kilograms (40 long tons). The lathe for which it is intended will weigh, when finished, some 350 tons.

It is interesting to note in connection with this firm that has grown from a modest beginning in 1866 to a plant now employing 1000 men, that the original founder, Dr. Ing. Ernst Schiess, is still active in the management, being the present chairman of the board of directors.

DE FRIES & CIE., A. G.

Across the river from Düsseldorf is Ober Cassel, and here we visited the works of de Fries & Cie., builders of machine tools, among others, the Ajax forging machine, under an agreement with Ajax Manufacturing Company, of Cleveland, Ohio.

Lathes, boring mills, milling machines, etc., are produced. One machine that needs especial mention is a vertical-spindle spline milling machine, made in three sizes. For narrow keyways and slots a two-lipped cutter is used; for wide slots a three-lipped cutter has been developed. The machine has found a wide field of usefulness.

The Employers' Liability Law

Special Correspondence

The new law in New York and its effect as pointed out by the Actuary of a Liability Insurance Company.

His proposal to end all litigation of this kind.

The law which recently became effective in the State of New York materially changes the status of industrial accidents. We quote from a letter of Frank E. Law, actuary of the Fidelity & Casualty Company of New York, to the *New York Times*.

The liability of employers is increased in two ways. In the first place, the fellow-servant and assumption of risk defenses have been practically destroyed and the burden of proof of contributory negligence has been put upon the employer. This radical change in the law affects all employers. In the second place, in certain employments determined to be especially dangerous the employer becomes liable to pay to an injured workman, or if the workman is killed then to his dependents, compensation whether the injury was caused by the fault of the employer or the fault of the workman. Hitherto it has been necessary to show that the employer was at fault in order to recover damages. No recovery could be had under other circumstances. As the law has stood heretofore, *but one workman in eight recovered anything;* under the new law all, or nearly all, workmen injured in the employments named in the law will receive compensation. Employees are not compelled to accept the compensation provided. They may, if they choose, sue under the common law and the employers' liability statutes instead. Owing to the preservation of this right of action and to the lack of clearness in the law as to just what employments are covered, much litigation is likely to result.

There is an impression that litigation will eventually be much diminished as a result of the new laws. This is very doubtful. Human nature will remain the same, and many injured workmen will be tempted by the possible large recoveries under the common law and employers' liability statutes, and casting aside the smaller though certain compensation, will elect to take a chance and sue for damages. The purpose of the law will thus largely be defeated. Since the employee retains the right to choose his remedy, the "ambulance chaser" will have as fruitful a field of operation as ever.

As a matter of fact, the liability insurance companies have never made any money on their business. The rates have never been equal to the losses and expenses, and have never kept pace with the increased liability of employers. In life insurance and fire insurance, the conditions surrounding risks have constantly grown better, owing to improved sanitation and greater medical skill in the one case and improved construction and equipment of buildings and better fire departments in the other. The liability insurance companies have sought to improve the risks they insured by inspections and instructing employers how to prevent accidents, but the improvements so effected have been more than offset by the greater liabilities imposed by law on employers. What money the liability insurance companies have made has been made from other branches of their business. The buying of lawsuits, which is what liability insurance is, has not proved remunerative to the companies.

It is the fighting of what are held under the law as unjust claims that makes so much litigation and so much expense. The waste is due to the system instituted by the community, and not to the companies. It would be far better to cut off entirely from employees any rights of action under the common law and employers' liability statutes and give in lieu thereof adequate benefits under a workmen's compensation law. Such an arrangement would probably put a stop almost completely to litigation and the great waste consequent upon it. But there are constitutional difficulties that probably could not be overcome.

[If there has been no money made in liability insurance, and Mr. Law should be in a position to know, then the whole system certainly needs changing. For we are told by what seems to be good authority that less than 30 per cent. of the premiums of about $30,000,000 reach the injured employee. A direct loss of 70 per cent. between the employer and the one who should receive it, shows a very inefficient system.

The injustice of the old way is shown in the fact that only one injured workman in eight received anything, while he received the 30 per cent. of the whole cost to employers. The other 70 per cent. would have helped the remaining seven who were unprovided for.

Mr. Law's suggestion in the last paragraph regarding cutting out all suits and providing adequate compensation is worthy of careful consideration. Mutual insurance seems likely to result from the proposed increase in rates.—ED.]

Automobile Engine Proportions—I

By A. G. Kessler
and G. W. Lewis

A digest of some of the principal proportions of four cycle gasolene automobile motors, based upon the average practice of about thirty of the best known manufacturers in the United States.

Where theory applies, the pressures and stresses are calculated back to the unit basis from prevailing practice. For other parts the relations of the proportions are expressed by equations found by plotting curves of the related dimensions, also determined from prevailing practice.

This article is one of a series of four dealing with current practice in automobile-engine proportions. During the past year the writers have spent considerable time collecting data which were furnished by some thirty of the best known automobile-motor manufacturers in the United States, and the material included is the result of careful study and investigation of such data. It may be well to mention that this work was done at Sibley College, Cornell University, under the supervision of Professors Hirshfeld and Diederichs, professors of gas engineering and experimental engineering respectively.

Division I. Rating of Automobile Engines

In preparing an average rating for automobile engines it was possible only to consider those of the four-cycle type. The formulas used were those adopted by the various engineering societies and automobile associations as follows:

Formula of the Association of Licensed Automobile Manufacturers,

$$H.P. = \frac{D^2N}{2.5} = 0.4\ D^2N.$$

Formula of the Royal Auto Club (British),

$$H.P. = 0.405\ D^2N.$$

Formula of the French Auto Club,

$$H.P. = 0.45\ D^2N.$$

In these formulas D = cylinder diameter in inches, and N = number of cylinders.

Formula of the Royal Auto Club (Swedish),

$$H.P. = \frac{D^2SNn}{15{,}240},$$

in which

D = Cylinder diameter in inches;
S = Stroke in inches;
n = Revolutions per minute;
N = Number of cylinders.

Formula of the New York Motor Boat Association,

$$H.P. = \frac{ANSn}{850},$$

where

A = Area of cylinder in square inches;
N = Number of cylinders;
S = Stroke in feet;
n = Revolutions per minute.

In order to compare these five formulas, they all must be reduced to the same form of equation, varying only in the constant. For example, consider the Association of Licensed Automobile Manufacturers' formula, already given, which is based upon a piston speed of 1000 feet per minute. In other words the revolutions per minute of the motor (for normal rating) are assumed such that the piston speed will be 1000 feet per minute.

Hence, piston speed = 1000 =

$$\frac{2 \times \textit{stroke in inches} \times R.P.M.}{12},$$

or

$$R.P.M. = \frac{6000}{\textit{stroke in inches}},$$

or

$$\frac{500}{\textit{stroke in feet}}.$$

Then the Association of Licensed Automobile Manufacturers' formula may be written

$$H.P. = (0.4\ ND^2)(R.P.M.)\left(\frac{\textit{stroke in feet}}{500}\right),$$

or

$$H.P. = \frac{ND^2S \times R.P.M.}{1250},$$

where symbols have the same meaning previously given.

The remaining formulas, on the same basis of a piston speed of 1000 feet per minute, reduce to the following forms:

Royal Auto Club (British) formula,

$$H.P. = \frac{ND^2S \times R.P.M.}{1235}.$$

French Auto Club formula,

$$H.P. = \frac{ND^2S \times R.P.M.}{1112}.$$

Royal Auto Club (Swedish) formula,

$$H.P. = \frac{ND^2S \times R.P.M.}{1270}.$$

New York Motor Boat Association formula,

$$H.P. = \frac{ND^2S \times R.P.M.}{1082},$$

in all of which the symbols have the following meaning:

D = Cylinder diameter in inches;
N = Number of cylinders;
S = Stroke in feet.

It will now be seen that these five formulas differ only in the constants, and consequently an average of these constants should give an average formula for the *rating of four-cycle automobile engines.*

	Constant.
A. L. A. M.	1250
British	1235
French	1112
Swedish	1270
N.Y. M. B. A.	1082
Average	1189

Therefore the average formula is

$$H.P. = \frac{ND^2S \times R.P.M.}{1189}.$$

The New York Motor Boat Association formula is used for rating marine, four-cycle engines, which, on the average, run at a much slower speed and therefore have a much higher volumetric efficiency than automobile engines, consequently giving the comparatively low constant shown. The average of the four automobile formula constants is 1216, so that the approximate average constant may be taken as 1200, for these engines.

Substituting this in the general formula,

$$H.P. = \frac{ND^2S \times R.P.M.}{1200},$$

for stroke in feet,

or

$$H.P. = \frac{ND^2S \times R.P.M.}{14{,}400},$$

for stroke in inches.

Reducing this equation to the original form of the Association of Licensed Automobile Manufacturers' formula, we have

$$H.P. = \frac{D^2N}{2.4}. \qquad (1)$$

This is on the basis of a piston speed of 1000 feet per minute.

It may be of interest to note that the original Association of Licensed Automobile Manufacturers' formula is the same as the average formula just obtained, although its derivation is totally different from the above. For convenience in handling, however, the constant in the equation as used at present has been changed to 2.5.

Maximum Horsepower Determination

From the preceding the normal rated horsepower can be determined for any motor. What, then, is the overload capacity of such a motor, or what is the maximum horsepower that it should give

at a piston speed of 1000 feet per minute? From the above average equation,

$$H.P. = \frac{N D^2 S \times R.P.M.}{1200},$$

the normal rated horse-power may be determined for any desired piston speed.

For maximum horsepower

$$Max.\ H.P. = \frac{N D^2 S \times R.P.M.}{K}$$

where K equals a constant to be determined from practice. The diameter of cylinder, stroke, number of cylinders and maximum horsepower obtained at a piston speed of 1000 feet per minute were determined from twenty-eight representative American motors and an average value of K found to satisfy this equation.

This value of K equaled 1120.

Therefore, on the basis of a piston speed of 1000 feet per minute, the maximum horsepower that an average motor should give will be

$$Max.\ H.P. = \frac{N D^2 S \times R.P.M.}{1120}. \qquad (2)$$

The overload capacity on the basis of a piston speed of 1000 feet per minute can then be found by comparing results obtained from (1), the formula for average normal rating, and (2), the formula for maximum rating, just developed. It will be found that a motor of average design should have an overload capacity at 1000 feet piston speed, of about 7 per cent. over its rated horsepower.

Influence of Volumetric and Mechanical Efficiency on Rating of Automobile Engines

The following data were taken from a series of tests on a Franklin motor by Messrs. Lay and Evans.

K = Product (D^2SNn) for one brake-horsepower output;

K' = Same as K, provided the volumetric efficiency were 100 per cent.;

K'' = Same as K', provided the mechanical efficiency were 100 per cent. also.

From the preceding discussion on rating, the following formula was developed:

$$B.H.P. = \frac{D^2 S N n}{14{,}400},$$

where

D = Cylinder diameter in inches;

S = Stroke in inches;

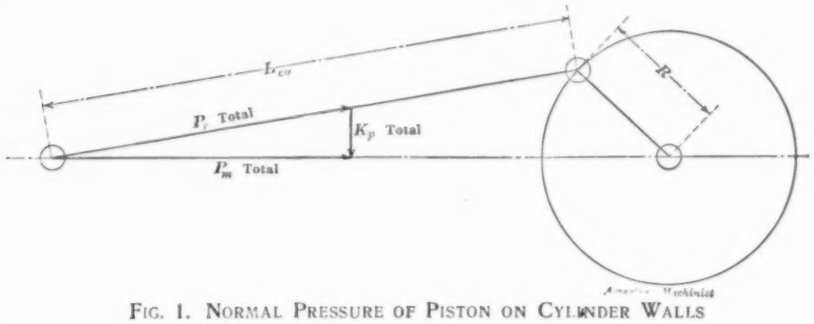


Fig. 1. Normal Pressure of Piston on Cylinder Walls

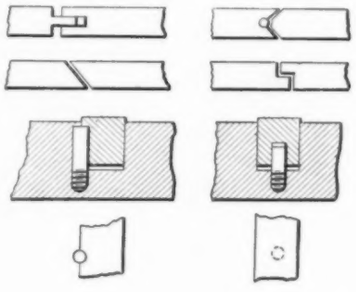


Fig. 2. Cutting and Fastening Piston Rings

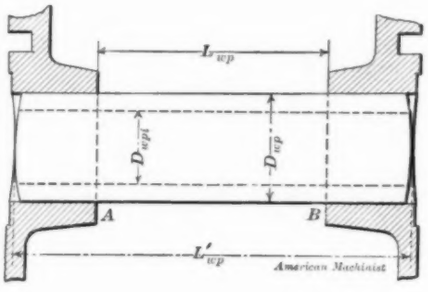


Fig. 3. Proportions of Piston Pin

N = Number of cylinders;

n = Revolutions per minute.

The values of K in the above table were computed as follows:

$$B.H.P. = \frac{D^2 S N n}{K},$$

(see first value in table)

$$K = \frac{16 \times 4 \times 4 \times 700}{12.4} = 14{,}430,$$

$$K' = 14{,}430 \times \frac{75}{100} = 10{,}800,$$

for a volumetric efficiency of 100 per cent. and a mechanical efficiency of 67 per cent.

Also

$$K'' = 10{,}800 \times \frac{67}{100} = 7{,}200,$$

for a volumetric efficiency of 100 per cent. and a mechanical efficiency of 100 per cent.

The average of all values of $K'' = 7200$. In other words, for perfect filling of the cylinders (a volumetric efficiency = 100 per cent.), the value of $K'' = D^2 S N n = 7200$ for one indicated horsepower.

Therefore, the quotient of K'' by K is the product of the mechanical and volumetric efficiencies, and the constant $K'' = 7200$ can be used in the following way.

If either the volumetric or mechanical efficiency of any motor be known, the other unknown value can be determined thus:

Assume the mechanical efficiency of a motor to have been found = 80 per cent.

Then the value of $K' = \frac{7200}{0.80} = 9000$,

and the volumetric efficiency $= \frac{9000}{K}$,

where $K = D^2 S N n$, as taken from test data.

Engine bore = 4 inches; stroke = 4 inches; number of cylinders = 4.

Speed, n	700	1,000	1,200	1,500	700	1,000	1,200	1,500
$B.H.P.$	12.4	17.1	19.5	21.4	12.2	16.8	21.4	23.2
K	14,430	14,960	15,730	17,930	14,720	15,250	14,370	16,560
Volum. efficiency (hot)	75	63	59	53	76	67	62	57
K'	10,800	9,400	9,300	9,500	11,200	10,200	8,800	9,400
Mechanical efficiency	67	74	77	78	67	64	78	79
K''	7,200	7,000	7,200	7,400	7,500	7,500	6,900	7,400

The symbols in this table have the following meaning:

n = Revolutions per minute;

$B.H.P.$ = Brake horsepower;

for a volumetric efficiency of 75 per cent. (hot) and a mechanical efficiency of 67 per cent.

Then

Division II. General Data

In the preparation of this work it was found advisable to consider only four-cycle motors, and results therefore apply only to engines of this class. All equations were determined in the following manner. Wherever it was considered desirable to obtain a relation between any two items, these items were plotted against each other on ordinary cross-section paper, and an average equation of the resulting stralght line, or curve, determined.

Weight of Engine (Complete)

The weight of engine (complete) was plotted against rated horsepower (Association of Licensed Automobile Manufacturers), and the following equation determined. This is approximately

true for all motors of 5 brake horsepower and above, either of the two-, four- or six-cylinder type.

$$We = 11.55 \times B.H.P. + 114 \text{ pounds},$$

where

We = Weight of engine (complete) in pounds;

$B.H.P.$ = Rated Association of Licensed Automobile Manufacturers horsepower.

Ratio of Stroke to Bore

The ratio of stroke to bore, for American cars, is given by the following equation:

$$L = 1.43\,D - 1.62 \text{ inches},$$

where

L = Stroke in inches, and

D = Cylinder diameter in inches.

The *Motor Age* for January 6, 1910, gives the following data relative to bore and stroke of 1910 motors on exhibition at the show of the Association of Licensed Automobile Manufacturers.

ASSOCIATION OF LICENSED AUTOMOBILE MANUFACTURERS.

	$1000	$2000	$2500	$4000
Average cost of car				
Average bore, D, inches	3.75	4.17	4.2	4.7
Average stroke, L, inches	4.5	4.5	4.6	5.06
Average ratio of L to D	1.2	1.08	1.095	1.075

The average ratio of stroke to bore of some sixty types of foreign engines was found to be

$$L = 3.1\,D - 6.8 \text{ inches},$$

where

L = Stroke in inches, and

D = Cylinder diameter in inches.

A comparison of American and foreign motors consequently shows that, for equal cylinder diameters, foreign motors have decidedly the longer stroke.

Ratio of Crank to Connecting-rod Length

For the average case, the length of connecting rod (from center of wrist, or piston pin, to center of crank pin) is given in terms of the crank length by the following equation:

$$L_{co} = 4.35\,R,$$

in which

L_{co} = Connecting-rod length, and

R = Crank length in similar units.

Division III. Automobile-engine Pistons

The automobile-engine piston (always of the so called "trunk" type) is required to perform two principal dynamic functions: First, it must transmit energy; second, it must take care of the normal thrust of the connecting rod, and in this capacity serves as a crosshead.

The first of these items leads to calculations for piston strength, and the second to calculations for allowable normal bearing pressures. For convenience, the second item will be taken up first.

Piston Length

The determination of piston length involves the consideration of the second item mentioned above, namely, the piston acting as a crosshead. In this capacity it is necessary that the normal pressure per square inch of side projected area of piston should not exceed certain allowable limits (to be determined later), thus decreasing friction to a minimum and making lubrication as easy as possible.

The normal bearing pressure may be calculated thus (see Fig. 1):

L_{co} = Connecting-rod length in inches;

R = Crank length in inches;

$(P_m\text{—}total)$ = Maximum piston thrust (maximum explosion pressure per square inch P_m multiplied by area of piston face in square inches);

$(K_p\text{—}total)$ = Total normal pressure on piston (unit normal pressure Kp times projected piston area);

D = Cylinder diameter in inches;

L_p = Length of piston in inches.

The total normal bearing pressure $(K_p\text{—}total)$ is equal, at its maximum, to a certain per cent. of the pressure in line of the piston, depending directly upon the ratio of crank (R) to connecting-rod length (L_{co}).

For $L_{co}/R = 4$, the maximum value of $(K_p\text{—}total) = 0.25$ of the total pressure in line of the piston.

For $L_{co}/R = 5$, the maximum value of $(K_p\text{—}total) = 0.20$ of the total pressure in line of the piston.

The piston generally receives its maximum normal pressure when the crank is at right angles to the connecting rod, or approximately at midstroke, and at this point the cylinder pressure is equal to perhaps less than half its maximum amount. Hence it is safe to assume that

$$(K_p - total) = approximately\ 0.1\,(P_m - total)$$

Therefore

$$(D \times L_p \times K_p) = (K_p - total) = 0.1\,P_m \frac{\pi D^2}{4}$$

Then

$$K_p = \frac{0.1\,P_m \frac{\pi D^2}{4}}{D \times L_p} = \frac{0.078\,P_m D}{L_p}. \quad (a)$$

From practice it has been found that the lengths of automobile-engine pistons vary with the cylinder diameter according to the following equation:

$$L_p = 1.14\,D \text{ inches},$$

where

L_p = Piston length in inches;

D = Cylinder diameter in inches.

Then from this last equation the length of piston can be determined for any cylinder diameter and from equation (a) the value of K_p can be found for any desired maximum explosion pressure, P_m.

For any cylinder diameter and for maximum explosion pressures ranging from 250 to 350 pounds per square inch, the maximum normal bearing pressures, as determined from equation (a), are found to run from 17 to 24 pounds per square inch of projected piston area.

Thickness of Piston Face

Piston faces may be made flat or arched. Common practice leans toward the use of flat faces, though in some cases they may be arched slightly outward or inward. When webs are used, stretching across the piston face, the latter is materially strengthened and stiffened. Theoretically, piston faces can be made slightly thinner when arched or webbed than when flat or unwebbed. In automobile practice this difference, however, is scarcely perceptible.

From practice the following equation gives the average thickness of piston face in terms of the cylinder diameter, for both webbed and unwebbed pistons.

$$T_{pf} = 0.044\,D \text{ inches},$$

where

T_{pf} = Thickness piston face in inches,

D = Cylinder diameter in inches.

The approximate limits in thickness of piston faces range from ⅛ to ¼ inch, the lower being set by the necessity of sound casting, and the upper by proper cooling requirements.

To accurately calculate stresses in piston faces is practically impossible. The common method so far seems to be to treat the piston face as a flat plate, fixed at the edges, and in this connection Bach's flat plate formula would seem to be applicable.

Bach's formula is

$$T_{pf} = 0.45\,D\sqrt{\frac{P_m}{S_b}},$$

in which

T_{pf} = Thickness piston face in inches;

D = Cylinder diameter in inches;

P_m = Maximum explosion pressure in pounds per square inch;

S_b = Maximum bending stress in piston face in pounds per square inch.

It will be seen that for maximum explosion pressures ranging from 250 to 350 pounds per square inch, the resulting bending stresses run from 25,000 to 35,000 pounds per square inch. It is well known that cast iron cannot be made to take any such load under regular working conditions and therefore this method of checking must be out of the question. For plates as small, well supported and rigid as automobile piston faces, it is consequently unfair to treat them as ordinary flat plates of larger dimensions, and the following method of

checking, therefore, seems the only reasonable one to be followed.

Consider the piston face a small plate subjected to the shearing action all around the inner circumference and loaded with the maximum total explosion load.

Then

$$\pi D_i \times T_{pf} \times S_s = P_m \times \frac{\pi D^2}{4},$$

where

D_i = Inner diameter piston face in inches;

T_{pf} = Thickness piston face in inches;

S_s = Shearing stress in pounds per square inch;

P_m = Maximum explosion pressure in pounds per square inch;

D = Cylinder diameter in inches.

From this equation the shearing stress can readily be calculated and gives results which are more consistent than checks made in any other way. For maximum explosion pressures ranging from 250 to 350 pounds per square inch, the resulting shearing stresses are found to run from 1400 to 2400 pounds per square inch. Temperature stresses have been neglected here, as their accurate calculation is a very doubtful matter.

Piston Webs

Webs for automobile-engine pistons are commonly either 2 or 4 in number. When two are used they are generally placed in the plane of the wrist-pin, or piston-pin, bosses. When four are used, two are placed in the plane just mentioned and the other two at right angles to these. From practice, the thickness of piston webs has been found to vary between ⅛ and ¼ inch, with an average of from ⅛ to 3/16 inch, for all cylinder sizes.

Piston-barrel Thickness

The walls of automobile piston barrels are commonly made to taper slightly, from a point near the wrist-pin center line toward the open end. The thickness of barrel at the open end varies from 3/32 to 3/16 inch, with a good average from ⅛ to 5/32 inch, for all sizes of motor pistons.

The barrel thickness underneath the piston rings is slightly greater than that at the open end, varying between ⅛ and ¼ inch, with an average of 3/16 inch for all sizes of engines.

Piston Rings

Piston rings for automobile engines are, in general, made eccentric. Plain rings would cost slightly less to manufacture but would of necessity be heavier and more bulky. The refined design necessary in automobile practice consequently warrants the use of the eccentric piston ring.

Outside Diameter of Finished Ring Blank

The finished outside diameter of the hollow cylinder or ring blank from which the rings are cut has been found to be

$$D_{bl} = 1.04\ D\ inches,$$

where

D_{bl} = Outside diameter ring blank in inches;

D = Cylinder diameter in inches.

Cutting, Fastening, Number and Width of Piston Rings

The methods by which piston rings are commonly cut and fastened to the piston are shown in Fig. 2.

The average number of piston rings used on all sizes of automobile pistons has been found to be four. Three rings are often used, and in some extreme cases five, but the latter number is quite uncommon.

For all sizes of motors the average width of ring at present in use is ¼ inch. Ring widths vary between 3/16 and 5/16 inch, but ¼-inch rings are by far the most common for all cylinder diameters.

Maximum Thickness of Eccentric Piston Rings

The maximum thickness of eccentric piston rings is given in terms of the cylinder diameter by the following equation:

$$(T_r - max.) = 0.04\ D + 0.01\ inch,$$

where

$(T_r - max.)$ = Maximum thickness eccentric piston rings in inches;

D = Cylinder diameter in inches.

According to theory (see Unwin's "Machine Design," Part II, page 251), in order to secure a constant unit stress in any section of the ring, and a constant unit bearing pressure around the circumference, the ring would have zero thickness at the cut and a maximum thickness opposite the cut. This, of course, would not be practical. It has been found, however, that, if eccentric rings be turned so that the thickness at the cut is 0.588 of the thickness opposite the cut (at the maximum section), the above conditions of bending stresses and bearing pressures are approximated for at least two-thirds of the circumference of the piston ring.

From practice it has been found that for the average case

$$(T_r - min.) = 0.637\ (T_r - max.)$$

and that $(T_r - min.)$ varies between 0.57 $(T_r - max.)$ and 0.8 $(T_r - max.)$

$(T_r - min.)$ = Minimum thickness of ring, or thickness at the cut;

$(T_r - max.)$ = Maximum thickness of ring, or thickness opposite the cut.

It is readily seen from these results that the smallest value of $(T_r - min.)$ is practically equal to the theoretical value given by Unwin.

Spacing of Piston Rings

The average automobile piston has four piston rings uniformly spaced between the piston head (or closed end) and the edge of the wrist, or piston pin nearest the closed end of the piston. An extra large ring is sometimes used to act as a band around the piston, holding the piston pin in place, the center line of the ring then coinciding with the center line of the wrist, or piston pin. Some few engines also use a small ring very close to the open end of the piston, which assists in the lubrication of the latter.

The distance between edges of rings uniformly spaced varies between ⅛ and ¼ inch, with an average of 3/16 inch for all sizes of motors.

Where engine cylinders are counterbored, the pistons generally are allowed to overtravel the counterbore to the center of the first piston ring, thus preventing the wearing of a shoulder at the end of the piston stroke. However, this is not always the case, as the first piston ring may be placed as far away from the piston face as is deemed suitable to prevent its excessive heating, with consequent danger of gumming and sticking.

In the average case (for all sizes of motors) the first ring is placed 3/16 inch from the piston face, with limits between 5/32 and ¼ inch.

Grooves for Piston Rings

The depths of piston-ring grooves depend primarily upon the maximum thickness of piston rings to be used, and the value of groove depth is consequently stated here as a function of the maximum ring thickness:

$$S_d = 0.75\ (T_r - max.) + 0.0875\ inch,$$

where

S_d = Depth of ring groove in inches;

$(T_r - max.)$ = Maximum thickness piston ring in inches.

The limits in depth of grooves may be taken between 5/32 and ¼ inch.

The width of the piston-ring groove must be just enough to give the ring an easy fit. Commonly the width of groove is made 0.001 inch greater than the width of piston ring.

Diametral Clearance on Pistons

Automobile-engine pistons are given clearance in proportion to their diameters, the clearance at the closed end, or top, being greater than at the open end, or bottom, because the closed end is subjected to much higher temperatures than the open end, and consequently expands a greater amount. The two following equations give the clearance at the closed and open ends of the piston in terms of

D, the cylinder diameter in inches; that is, the amount by which piston diameter is less than cylinder diameter:

Diametral clearance at closed end $= 0.00174\ D$ *inches;*

Diametral clearance at open end $= 0.001\ D$ *inches;*

Weight of Automobile-engine Pistons

For the average automobile-engine piston, the weight may be found approximately from the following equation:

$$W_p = 2.06\ D - 4.43\ pounds,$$

in which

W_p = Weight of piston in pounds;
D = Cylinder diameter in inches.

Division IV. Wrist, or Piston Pins

In order to decrease the weight of reciprocating parts, and at the same time increase the stiffness of wrist, or piston pins, the latter are commonly made hollow. Piston pins may be bored out, or they may be made of steel tubing, properly hardened and finished. They must be designed with two objects in view: (1) with reference to strength, and (2) with reference to allowable bearing pressure, the latter being carefully considered so as to facilitate lubrication.

(1) Design of Piston Pin for Strength

In the discussion which follows, the symbols used have the following meaning:

D_{wp} = Outside diameter piston pin, in inches;
D_{wpi} = Inside diameter piston pin, in inches;
L_{wp} = Bearing length of piston pin in inches;
D = Cylinder diameter in inches;
P_m = Maximum explosion pressure in pounds per square inch of piston face;
S_b = Allowable fiber stress in outer fiber in pounds per square inch;
K_{wp} = Maximum allowable bearing pressure in pounds per square inch of projected piston pin area;
I = Moment of inertia of pin section;
e = Distance to outer fiber = half diameter of piston pin.

Then, considering the piston pin a beam supported at the inside ends of the piston bosses (or at points A and B, Fig. 3) and loaded at its center by the maximum explosion load of the engine, the resulting bending moment is

$$M_b = \frac{P_m \cdot \frac{\pi D^2}{4}}{4} \times L_{wp} = \frac{S_b I}{e},$$

from which

$$D_{wp} = \sqrt[3]{\frac{2\ P_m\ D^2\ L_{wp}}{S_b}} \qquad (b)$$

for solid pins, and

$$S_b = \frac{2\ P_m\ D^2\ L_{wp}}{D^3_{wp}} \qquad (c)$$

for solid pins; also

$$S_b = \frac{2\ P_m\ D^2\ L_{wp} \cdot D_{wL}}{D^4_{wp} - D^4_{wpi}} \qquad (cc)$$

for hollow pins.

(2) Design of Piston Pin for Bearing Pressure

The total maximum pressure exerted on the piston-pin bearing area is the total maximum pressure exerted on the engine piston.

It will be well to note here that in these cases, referring to piston pins, the maximum explosion pressure is considered to occur when the piston is at the beginning of its stroke, or in the dead-center position, which is approximately true, and accurate enough for these calculations. This being the case, the following equations result:

$$K_{wp} \times D_{wp} \times L_{wp} = \frac{P_m \cdot \pi D^2}{4}.$$

From which

$$D_{wp} = \frac{P_m \cdot \pi D^2}{4\ K_{wp} \cdot L_{wp}} \qquad (d)$$

and

$$K_{wp} = \frac{P_m \cdot \pi D^2}{4\ D_{wp} L_{wp}} \qquad (e)$$

in which the symbols are the same as previously given.

From practice the following equations have been determined, relative to outside and inside diameters of hollow piston pins:

$$D_{wp} = 0.34\ D - 0.53\ inch$$

and

$$D_{wpi} = 0.572\ D_{wp}\ inches,$$

in which the symbols are again the same.

For the average case, the bearing length of piston pins may be found from

$$L_{wp} = 2.25\ D_{wp}\ inches,$$

where symbols are as before.

Maximum Piston-pin Bearing Pressures and Bending Stresses

From the theoretical equations developed above, and from the empirical equations just determined, the maximum bending stresses and maximum bearing pressures can be found.

On the basis of a maximum unit explosion pressure of 250 pounds: Maximum bending stresses (S_b) run from 23,000 to 29,000 pounds per square inch; maximum bearing pressures (K_{wp}) run from 1600 to 2000 pounds per square inch.

On the basis of a maximum unit explosion pressure of 300 pounds: Maximum bending stresses (S_b) run from 26,000 to 35,000 pounds per square inch; maximum bearing pressures (K_{wp}) run from 1900 to 2400 pounds per square inch.

On the basis of a maximum unit explosion pressure of 350 pounds: Maximum bending stresses (S_b) run from 32,000 to 40,000 pounds per square inch; maximum bearing pressures (K_{wp}) run from 2200 to 2800 pounds per square inch.

Overall Length of Piston Pins

Piston pins are made less in total length than the cylinder diameter, according to the following equation (for average conditions):

$$L'_{wp} = 0.95\ D\ inch,$$

in which

L'_{wp} = Total piston-pin length in inches;
D = Cylinder diameter in inches.

Position of Piston Pin in the Piston

For the average case the distance from the piston face to the center line of the piston pin $= 0.5\ L_p$, where L_p = length of piston. This ratio was found to vary between 0.4 and 0.57 L_p, for different types of automobile-engine pistons.

Piston-pin Bosses

The length of piston-pin bosses depends entirely upon the bearing length of the wrist pin. This item has been given in terms of the piston-pin diameter, and the length of boss can therefore be readily calculated.

The diameter of the boss (outside) has been found for the average case to be

$$D_{wpb} = 1.2\ D_{wp} + 0.25\ inch,$$

where

D_{wpb} = Outside diameter piston-pin boss in inches;
D_{wp} = Outside diameter piston pin in inches.

Piston-pin Weights

The weights of hollow wrist, or piston pins may be determined for average conditions from the following equation:

$$W_{wp} = 0.276\ D - 0.65\ pound,$$

in which

W_{wp} = Weight of hollow piston pin in pounds;
D = Cylinder diameter in inches.

Strength of Chains

A handy and reasonably accurate rule for estimating the safe working strength of a chain is as follows:

Express the diameter of wire or bar out of which the links are made, in 16ths of an inch. Square this number and multiply it by 80, giving safe working load in pounds.

Example:

Chain links made of ½-inch wire. ½ inch = 8 sixteenths; $8^2 = 64$; $64 \times 80 = 5120$ pounds safe working load. The proof test of ½-inch chain is 7500 pounds, or approximately 1½ times the safe working load.

Modern Gear Cutting and Grinding*

By Luther D. Burlingame†

Data pertaining to two important shop processes, including rates of speed and feed for cutting gears of steel and cast iron; and limits desirable in grinding various classes of work to running, forcing or shrinking fits.

*Presented at joint meeting of Institution of Mechanical Engineers and American Society of Mechanical Engineers.

†Chief draftsman, Brown & Sharpe Manufacturing Company.

The data sheet, Fig. 1, gives data for commercial work in cutting 16-pitch cast-iron gears with ordinary carbon-steel cutters, high-speed steel cutters, and with and without an air blast. The gears cut when these records were made are all gears that passed inspection and were put into use. The last gear of each group cut before sharpening the cutter was preserved, also samples of chips from each cut.

It will be noted that the use of the air blast adds materially to the rate of production, as will be seen by comparing the feed in inches per minute of Nos. 1 and 3, where a gain of nearly 70 per cent. is made when using the air blast with carbon cutters, and by comparing Nos. 2 and 4, where a gain of 40 per cent. is made when using the air blast with high-speed cutters.

The high-speed steel cutters with the air blast give an increase of production of almost 4 to 1 over the carbon cutters without the air blast. In cutting cast-iron gears of coarser pitches the gain is in about the same proportion. Even under the fastest cuts the gear teeth show surprisingly little tendency to break out at the back, although cut without being supported.

Fig. 3 shows the method of applying the air blast. A Sturtevant blower was used, the air being supplied from a tube 1¼ inches diameter at a pressure of about 1½ ounces per square inch, this being sufficient to cool the cutter and keep the chips cleared away.

Cutting Steel Gears

The following records are of commercial work done in the gear department of the Brown & Sharpe Manufacturing Company. In the first example three finishing cutters were used in a gang, finishing three teeth at once. In the second, better results were obtained by using a stocking and finishing cutter together than by using two finishing cutters. The data for these examples are as follows:

a Gears of steel castings, 70,000 pounds tensile strength, 3 pitch, 5 inches face, 67 teeth; cutter, 6 inches diameter, 1¼ inches hole, 52 revolutions per minute, 81 feet surface speed per minute, 2 9/16 inches feed per minute; feed, 0.049 inch per revolution of cutters. The three cutters cut three gears in 67 minutes each, without sharpening the cutters which were than in good condition and could have cut several gears more.

b Gears of steel castings, very hard, 3 pitch, 5 inches face, 51 teeth; the cutters, 6 inches diameter, 1¾ inches hole, 28.61 revolutions per minute, 45 feet surface speed per minute, 1 3/16 inches feed per minute; feed, 0.042 per revolution of cutters; cutting time, 5½ hours. Oil was used as a lubricant.

The roughing cutter used in the second example was a new design of stepped stocking cutter shown in Fig. 3.

Roughing out Gear Teeth

The following record was made with the new design of stocking cutter in roughing out gear teeth:

Gear blanks of machinery steel, 65-000 pounds tensile strength, 4½ inches diameter, 6 inches face; cutter, 3-pitch stocking, 5¼ inches diameter, 1½ inches hole, 90 revolutions per minute, 124 feet cutting speed per minute, 7 inches feed per minute; feed, 0.078 inch per revolution of cutter. Cut 15 teeth, 0.749 inch deep; total number of inches cut, 90. Cutter in good condition at end of cut. Test made with old 7½-horsepower motor belted to countershaft of the machine. Efficiency of motor, 78½ per cent.

Running Fits. Ordinary Speed.

To ½" diameter, inc	0.00025 to 0.00075	Small
To 1" diameter, inc	0.00075 to 0.0015	Small
To 2" diameter, inc	0.0015 to 0.0025	Small
To 3½" diameter, inc	0.0025 to 0.0035	Small
To 6" diameter, inc	0.0035 to 0.005	Small

Running Fits. High Speed, Heavy Pressure and Rocker Shafts.

To ½" diameter, inc	0.0005 to 0.001	Small
To 1" diameter, inc	0.001 to 0.002	Small
To 2" diameter, inc	0.002 to 0.003	Small
To 3½" diameter, inc	0.003 to 0.0045	Small
To 6" diameter, inc	0.0045 to 0.0065	Small

Sliding Fits.

To ½" diameter, inc	0.00025 to 0.0005	Small
To 1" diameter, inc	0.0005 to 0.001	Small
To 2" diameter, inc	0.001 to 0.002	Small
To 3½" diameter, inc	0.002 to 0.0035	Small
To 6" diameter, inc	0.003 to 0.005	Small

Standard Fits.

To ½" diameter, inc	Standard to 0.00025	Small
To 1" diameter, inc	Standard to 0.0005	Small
To 2" diameter, inc	Standard to 0.001	Small
To 3½" diameter, inc	Standard to 0.0015	Small
To 6" diameter, inc	Standard to 0.002	Small

Driving Fits.

To ½" diameter, inc	0.0005 to 0.001	Large
To 1" diameter, inc	0.001 to 0.002	Large
To 2" diameter, inc	0.002 to 0.003	Large
To 3½" diameter, inc	0.003 to 0.004	Large
To 6" diameter, inc	0.004 to 0.005	Large

Forcing Fits.

To ½" diameter, inc	0.00075 to 0.0015	Large
To 1" diameter, inc	0.0015 to 0.0025	Large
To 2" diameter, inc	0.0025 to 0.004	Large
To 3½" diameter, inc	0.004 to 0.006	Large
To 6" diameter, inc	0.006 to 0.009	Large

Driving Fits. For Such Pieces as Are Required to Be Readily Taken Apart.

To ½" diameter, inc	Standard to 0.00025	Large
To 1" diameter, inc	0.00025 to 0.0005	Large
To 2" diameter, inc	0.0005 to 0.00075	Large
To 3½" diameter, inc	0.00075 to 0.001	Large
To 6" diameter, inc	0.001 to 0.0015	Large

Shrinking Fits. For Hardened Shells ¾" Thick and Less.

To ½" diameter, inc	0.00025 to 0.0005	Large
To 1" diameter, inc	0.0005 to 0.001	Large
To 2" diameter, inc	0.001 to 0.0015	Large
To 3½" diameter, inc	0.0015 to 0.002	Large
To 6" diameter, inc	0.002 to 0.003	Large

Shrinking Fits. For Shells, etc., Having a Thickness of More Than ¾".

To ½" diameter, inc	0.0005 to 0.001	Large
To 1" diameter, inc	0.001 to 0.0025	Large
To 2" diameter, inc	0.0025 to 0.0035	Large
To 3½" diameter, inc	0.0035 to 0.005	Large
To 6" diameter, inc	0.005 to 0.007	Large

Grinding Limits for Holes.

To ½" diameter, inc	Standard to 0.0005	Large
To 1" diameter, inc	Standard to 0.00075	Large
To 2" diameter, inc	Standard to 0.001	Large
To 3½" diameter, inc	Standard to 0.0015	Large
To 6" diameter, inc	Standard to 0.002	Large
To 12" diameter, inc	Standard to 0.0025	Large

GRINDING LIMITS FOR CYLINDRICAL PIECES.

Note.—These limits should be followed under ordinary conditions. Special cases should always be considered, as it may be desirable to vary slightly from the tables.

16 Pitch Cast Iron Gears, ¾" Face, 13,000 Lb. Tensile Strength. Cutter 2½" Diameter, 1" Hole, 15 Teeth.

Number	1	2		3		4		5		
Kind of Steel for Cutter	Carbon	High Speed		Carbon		High Speed		High Speed		
With or Without Air Blast	Without	Without		With		With		With		
Number of Gears Cut at once	5	4		4		4		4		
Revolutions per Minute of Cutter	130	285		180		340		340		
Periphery Speed of Cutter in Feet per Minute	85	186		118		222		222		
Feed in Inches per Minute	5⅜	15		9		21		18		
Total Face of Gang	4"	3 3/16"		3 3/16"		3 3/16"		3 3/16"		
Number of Teeth in Gear being Cut	35	42	48	70	72	78	80	80	84	90
Cutting Time per Setting in Minutes	32	12.6	15	35	36	18.2	18.6	27	28	25.5
Number of Teeth Cut before Resharpening Cutter	3,500	6,684		5,534		12,236		25,502		

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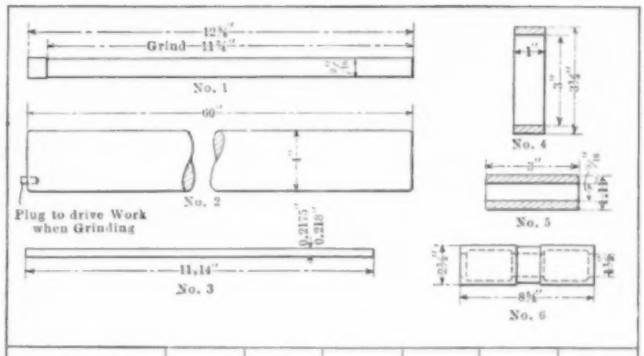
FIG. 1. EXAMPLES OF COMMERCIAL GEAR CUTTING



Number	1	2	3	4		5	6
Material	Soft Machinery Steel	Machinery Steel	Mach. Steel Case-Hardened	Mach. Steel Case-Hardened		Cast Iron	Bearing Bronze
Part Ground	External	External	External	Internal		External	External
Amount of Stock Removed (in Diameter)	.012" Roughing .002" Finishing	.025" Roughing .006" Finishing	.005" Roughing .001" Finishing	0.018" to 0.020"	0.010" to 0.012"	0.020" to 0.025"	0.012" to 0.015"
Required Limit	Standard to 0.00025" Small	Standard to 0.001" Small	Standard to 0.0005" Small	Std. to 0.0005" Large	Std. to 0.0005" Large	Standard to 0.0005" Small	Standard to 0.0005" Small
Number of Pieces Completed per Hour	13	3.5	15	16	20	54	32 (1 Man) 59 (2 Men)
In Lots of	100	50	500	200		200	100

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FIG. 4. EXAMPLES OF COMMERCIAL GRINDING

Gross horsepower used, 5.089. Net horsepower, 3.99 - 110 volts, 40 amperes.

GRINDING DATA, PLAIN AND UNIVERSAL GRINDING MACHINES

The examples of commercial grinding given in Fig. 4, illustrate what is being done under actual working conditions in commercial work on the variety of pieces indicated, which are of various materials and are both soft and hard. A reversal of the usual rule, where economy is gained by having one man operate more than one machine, is shown in example 6 where work is most economically produced by having two men run one machine, that is, having one man operate the machine and a helper drive the work on and off the arbor. All other data are based on one man to a machine.

These pieces passed inspection within the limits given. The average loss from work of this class coming below the required limit or being otherwise spoiled is less than ¼ of 1 per cent.

GRINDING LIMITS

The limits given in the table can be recommended for use in the manufacture of machine parts to produce satisfactory commercial work. As there emphasized, however, there must be individual consideration in each particular case to determine whether special conditions exist so as to require different limits from those given in the table.

Following such a table blindly may lead to more unsatisfactory results than to have no table at all. It is intended to be used only in the manner above pointed out.

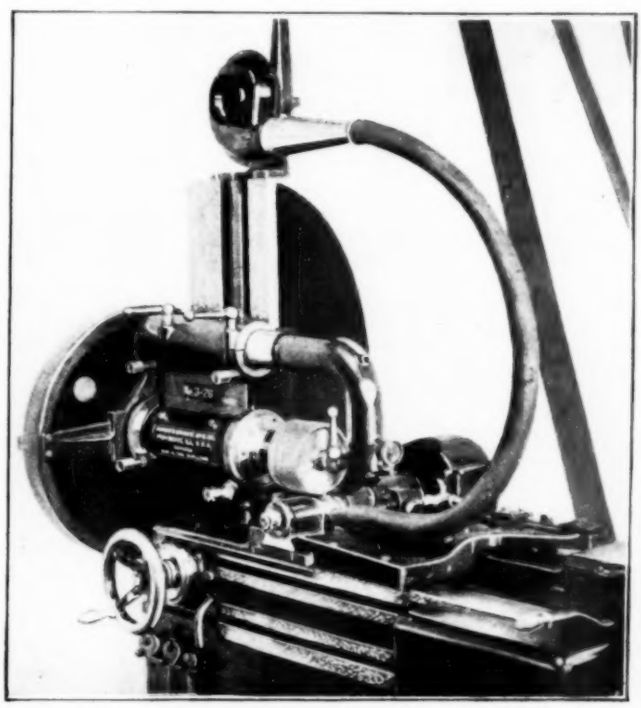


FIG. 2. AIR BLAST ON AUTOMATIC GEAR CUTTER

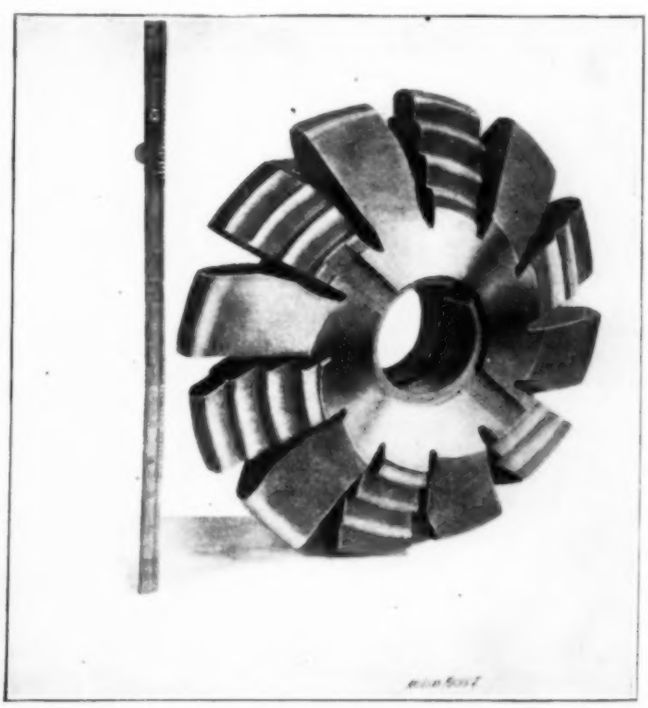


FIG. 3. STEPPED STOCKING CUTTER

Efficiency of Oil Tempering Furnaces

By George Coles

The oil bath as compared with dry-heat tempering by color. Necessity of agitating the bath and its uniformity in tempering a multiplicity of pieces. Kind of furnaces used.

An article describing the method of hardening and tempering gears at the Stevens-Duryea factory, says: "It having been found by experience that the bath of hot oil with a thermometer to record the temperature is not reliable."

In all my experience in the hardening room, this is the first time I have heard that the oil tempering furnace could not be relied upon. Under certain conditions you may not get quite the results that you want, but with all things favorable, the oil tempering furnace is absolutely reliable.

Details Required on Furnace

The furnace must be of first-class design with the burners judiciously placed, so as to distribute the heat uniformly and keep the burners properly adjusted. Then the furnace will heat up at about the same speed all the time. This is important, as sometmes the furnace runs faster than at others.

My experience has been that to draw the temper too fast reduces the toughness.

The next thing of importance is a thermometer that reads from 200 to 900 degrees Fahrenheit.

The next is the agitation of the oil. This must be looked after if good results are expected.

Generally, oil tempering furnaces are so constructed that the heat is applied to the oil pot from the sides, bottom and ends. Thus the oil that is nearest these parts gets hot first, leaving the center portion somewhat cooler. In order to overcome this, the oil must be agitated.

The Furnace Used

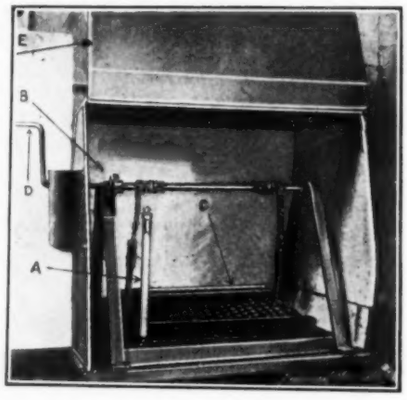
In my furnace, which is shown in the illustration, I have a windlass arrangement connected to the frame of the furnace. To this a basket or frame *C* is hung by chains. The basket is a double plate arrangement full of ⅞-inch holes. The holes in the lower plate are staggered from the upper, so that nothing will drop into the pot. The shaft has a crank end *D* to raise and lower the basket, and a ratchet and dog *B* to hold it in any position.

By means of this basket I agitate the oil by raising and lowering it quickly, two or three times every few minutes. German cylinder oil which flashes at about 650 degrees Fahrenheit, is used in the furnace, which is made by the American Gas Furnace Company. Two thermometers are used like the one at *A*. One of these is used continuously, and the other is kept for testing. A hinged door *E* covers the furnace.

Color Versus Oil Tempering

Sometimes gears are harder at one end than the other and thus one end should have the temper drawn more than the other. To accomplish this, draw the softest end to the right temperature. After reaching this temperature all over, by immersing in the oil, place the side of the gear that is tempered in the air above the oil, and the part that has to be drawn more in the oil. Have it in that position until the proper temperature is reached for that particular hardness.

In this case the oil need not be agitated as it is all getting hotter with the same rapidity. It is necessary sometimes to dip in cold oil, the part that is tempered to prevent the hot oil from drawing it any lower.



Oil Tempering Furnace

Drawing to color is the old antiquated method, but a good job can be done that way at times. It is entirely out of the question, however, to temper 500 chisels or 500 taps or drills by color and have them all alike, but with the oil-tempering furnace the whole lot can be tempered absolutely alike, to say nothing about the difference in time of the two operations.

Operation of Oil Bath

There is one thing in connection with oil-tempering furnaces on which our experts on tempering are making a serious mistake. It is to get the furnace to the right temperature and then immersing the work and wait until it gets to the right temperature again, and continuing this operation until through with the tempering.

The proper way is to put the work in cold and bring both the furnace and the work up to the right temperature together. If the work is to be boiled, put it into a cold boiler and bring it up to 212 degrees Fahrenheit, then put it into the oil.

Just think this over for a minute. Don't you think that a tap that has been hardened and cooled and then put into oil that is 460 degrees Fahrenheit is subjected to a very great strain by this sudden change in temperature? The same applies to any piece of work that has thick and thin parts. These cannot be successfully drawn to color.

Uniformity of Temperature

In some cases it is necessary to have a piece of work considerably harder in some parts than in others, and this can be successfully done in the oil-tempering furnace. The work is drawn all over to the hardest temper, then the parts to be drawn lower are left in the oil, while the remainder of the piece is in the air. That can easily be done with the rachet and dog arrangement shown.

Another objection to the color-tempering of gears is that every tooth must be polished. If, as in heating to harden, the piece must be turned and watched, in order to get an even heat, the same would have to be done in tempering, but with far greater care, and a man could do only one at a time. By the oil method several can be done at once and have them absolutely alike, the number of course depending on the size of pieces and capacity of furnace.

Finding the Defects in Warped Embossing Dies

Those familiar with forming and embossing dies for thin sheet-metal goods, will no doubt have had trouble at one time or another with dies which have altered their shape through peening action or from the relieving of the internal strains which permit the dies to warp, resulting in poor work.

Sometimes it is difficult to locate the exact position and amount of this trouble. Some toolmakers prefer to use a surface plate and hight gage. While this method is good on some classes of work it is very tiresome, and on some types of dies takes up a great deal of time. The location and extent of a distortion can be found in a few minutes by this method: Take pieces of round solder wire and lay them across the bottom die at intervals of half an inch or less. Bring the upper die down. The wires will show the distortion which can readily be measured with a micrometer.

Two Railroad Shop Kinks

By W. J. Shadle*

An oil-burning apparatus for melting babbitt from old crossheads and how it is made.

A convenient transfer truck for handling car and engine truck wheels around the shop.

*General foreman, Chicago & Northwestern Railway, Clinton, Ia.

Before rebabbitting crossheads it is necessary to melt off the old worn babbitt, and the following illustrations show how this is done in the shops of the Chicago & Northwestern railway at Clinton, Iowa.

The crosshead to be treated is stood on end in the center of the melting stand at *A*, Fig. 1, which bears a strong resemblance to an ordinary portable forge. There is a hole in the bottom of the upper pan and above this is a round supporting plate, which can be seen in Fig. 5, on which the crossheads rest. This enables the melted babbit to run down through the center into the cast-iron pot below, which catches the metal so that it can be used over again.

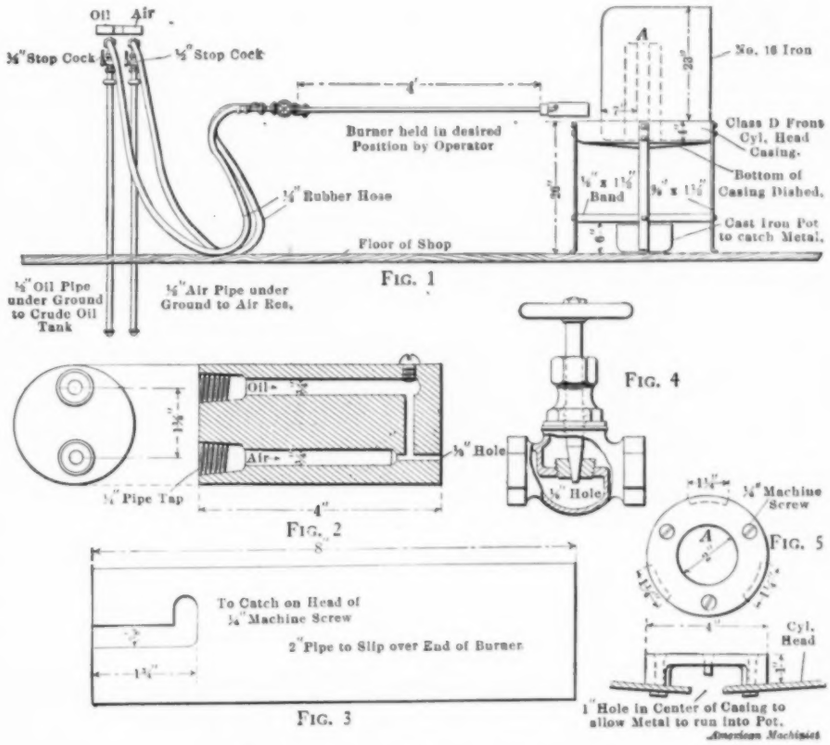
The arrangement of the crude oil and the air-pipe line is clearly shown in Fig. 1, which gives all necessary dimensions, so that anyone who desires can easily make up an outfit of this kind.

Figs. 2 and 3 show the burner and the hood. The burner is made of a solid piece of brass, having two holes drilled lengthwise, as can be seen, marked "oil" and "air." These are tapped for ¼-inch pipe and a crosshole brings the oil down into the air jet and out through the ⅛-inch hole. The hood is a piece of 2-inch pipe, which slips over the brass burner nozzle, being held by the bayonet point by the head of ¼-inch machine screw. This confines the flame so that it can be directed against any portion of the crosshead desired.

Fig. 4 shows how a regular ⅜-inch globe valve has been converted into a very satisfactory needle valve. The seat has been tapped and plugged with ½-inch gas-pipe plug, into which the end of the brass stem, which has been turned to a needle point, is made to bear. The small end of the hole through the plug is ⅛ inch.

Fig. 6 shows very clearly just how the burner is used, the outlines of the crosshead being visible outside of the flame. This also gives a good idea of the way in which the apparatus can be handled, and the size of the flame obtained. This has been in use in these shops since 1904 and has proved very satisfactory in every way.

Fig. 7 shows a very convenient form of truck for handling car or locomotive truck wheels around the shop. This needs practically no explanation, as it can be readily seen how the supporting bar is hung from the axle of the small pair of wheels. It is made so as to be



Details of the Babbitt Melter

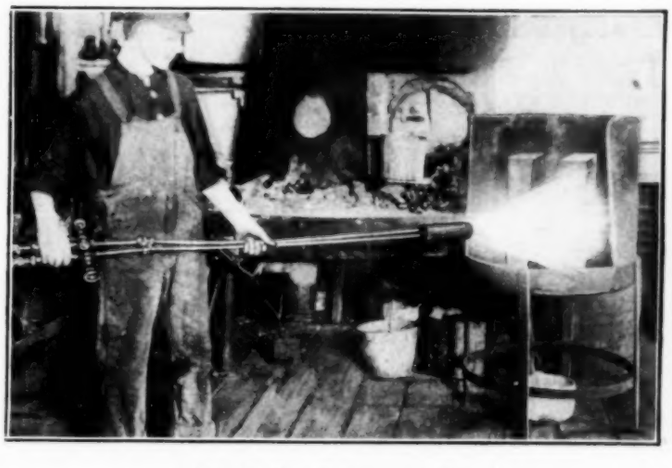


Fig. 6. The Burner in Use

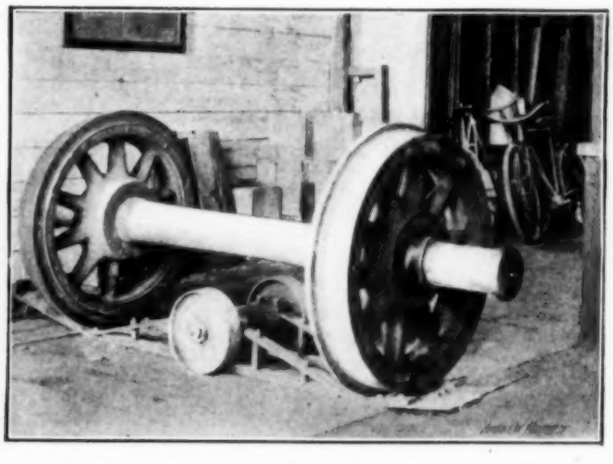


Fig. 7. A Transfer Truck for Car Wheels

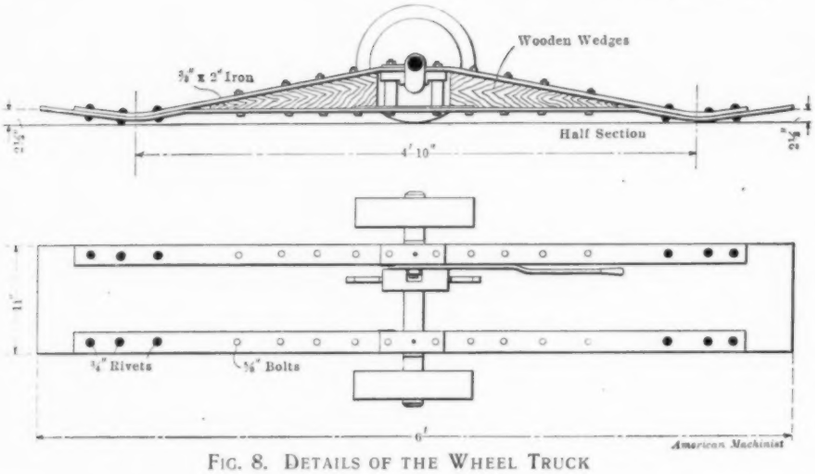


FIG. 8. DETAILS OF THE WHEEL TRUCK

very close to the floor, in order that wheels may be readily rolled on it, and it can then be easily moved to any part of the shop which may be desired. The wheels being carried rest between the braces which support the bottom, or carrying part of the small truck, and hold the wheels in place while they are being transported around the shop.

The carrying beam is supported by a crooked or eccentric axle so that the load can be easily raised from the floor by means of a gear and pinion operated by the lever shown. Fig. 8 shows this in detail. Wooden wedges between the iron straps, held by vertical through bolts, give stiffness to the truss framework to carry the heavy weight of the car wheels.

Pattern and Mold for Smokestack

By W. Potter

Laying out the sweeps, deciding on parting lines and building up stock for the part that has to have a solid pattern.

The cores necessary and methods of making them.

The rigging and materials needed for molding. Methods employed building up the mold, setting the cores and pouring the casting.

Owing to the increased size of boilers now being made for locomotives on British railways it has become necessary to adopt shorter smokestacks, proportional to the increase of boiler diameter, as the total hight from the track-rail to the top of the stack is limited. Owing to this, and the fact that the stacks are also being made larger in diameter, it has become possible to modify the method of making the molds for the cast-iron ones.

Whereas in the making of the longer stacks, with hoods, the whole of the inside has hitherto been cored, it is now possible to make the short ones without core-boxes, except in the case of the lightening core for the cornice.

PARTINGS FOR PATTERN

In Fig. 1 is shown a sectional view, across the locomotive, of the new form of stack. A lengthwise sectional view would be the same except that the lower flange would be flat to conform to the shape of the boiler. Iron patterns are used, that are made in three portions. Fig. 2 shows where these are divided for convenience of molding. As the stack castings should be only ¼ to 5-16 inch thick it is necessary to make a good job of the patterns, machining them where possible.

SWEEPS FOR UPPER PORTION

To mold the upper part of the stack the edge *F* of board *E*, Fig. 3, is cut to the shape of the outside of the body to form a sweep for part *B* in Fig. 2. Edge *G* is made to sweep the inside and thus form the core for the stack in green sand.

When this has been dried more loam is put on to make up the thickness of metal required. It is made to the shape of the outside of the pattern by means of the other edge, *F*, of the board. This in turn is dried and then used as a pattern.

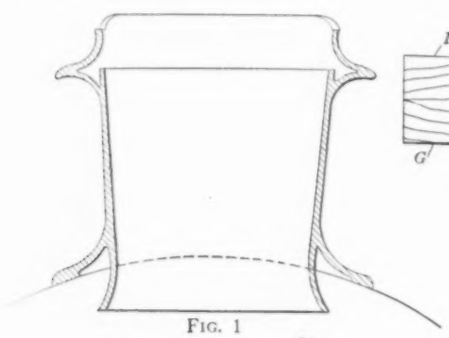


FIG. 1

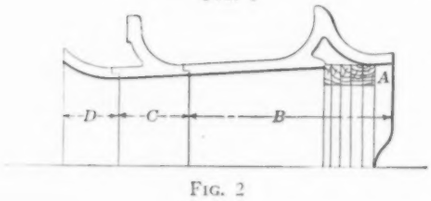


FIG. 2

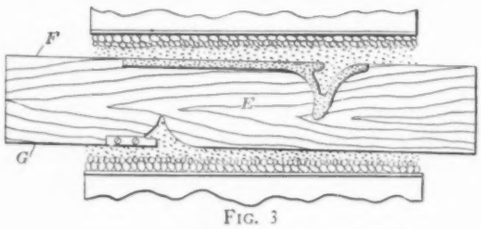


FIG. 3

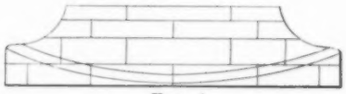


FIG. 4

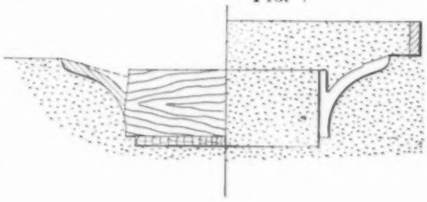


FIG. 5

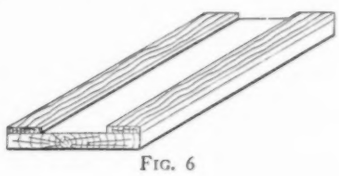


FIG. 6

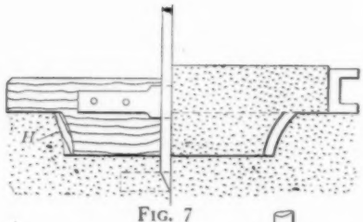


FIG. 7

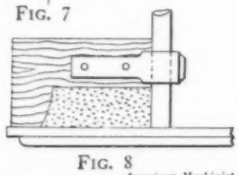


FIG. 8

American Machinist

LOCOMOTIVE SMOKESTACK AND RIGGING WITH WHICH TO MOLD

When the mold is made the extra loam is stripped off, and the core that remains is blacked and made ready for use in the mold.

Pattern for Middle Portion

The middle portion *C*, Fig. 2 requires a more elaborate pattern. This is built up and carved away to the required form to follow the sweep of the boiler as shown

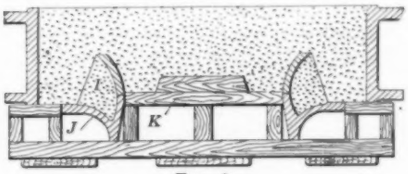


Fig. 9

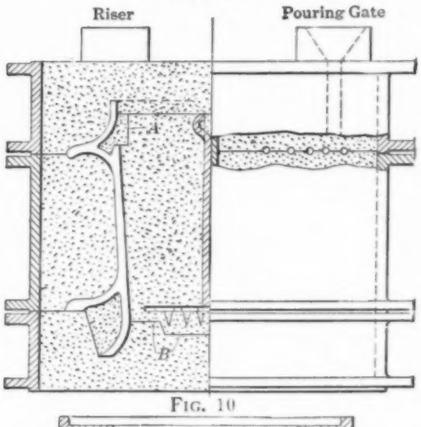


Fig. 10

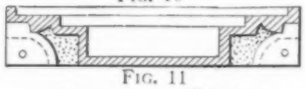


Fig. 11

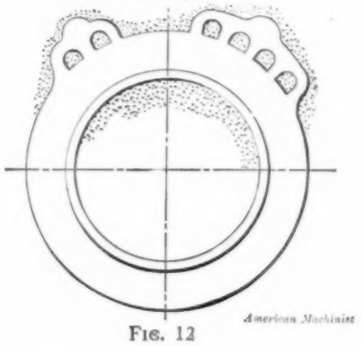


Fig. 12

Mold with Cores, Pouren and Gates

in Fig. 4. When this is done a mold is made from it, preferably in dry sand, so as to allow for its being lined up with clay which is to correspond to the thickness of the metal.

The left-hand side of Fig. 5 shows the mold with the clay strips laid in. The right-hand side shows the mold with strips removed and ready for pouring. The clay strips are rolled to the necessary thickness on a piece of board on which are nailed two strips of wood as shown in Fig. 6. Wax can be used in place of clay, if more convenient. The cope is rammed up on this mold and when lifted off again the clay is removed. The mold is thus made to form a casting of the shape required.

Pattern or Sweep for Lower Portion

A pattern for the third portion *D*, Fig. 2, may be made and rammed up in the sand, or the mold can be formed with a sweep-board. In the latter case a mold corresponding to the shape of the inside of the intended casting is first swept out. The cope is rammed up on this and then removed.

To form the mold for the outside of the casting the same board is used by moving it away from the spindle, or a piece *H* equal to the thickness of metal required may be fixed on the end of the board. This method is shown in Fig. 7. In the first case the core could be swept out of green sand on a pin-board as shown in figure 8.

Building Up Mold

To mold the stack, the pieces *D* and *C*, Fig. 2, are first put together and laid upside-down on a follow board *K*, as shown in Fig. 9. The space marked *I* is then used as a core-box, at the same time making provision for a point all round. The drag is rammed up on this and then the whole lot is turned over and the follow board removed.

The bottom is now ready to receive the main, or body part of the pattern, *B*. After this it is put in position, the middle box, or cheek flask, is fixed on and rammed up with sand, level with the center of the cornice that is the next joint of the mold.

The inside of the body is used as if it were a core box for making a dry-sand core, the part *B* forming a seating for the same. When the cope is put on and rammed up on this, the first of the series of molding operations is completed.

Finishing Mold

The next part is working downward, the cope is first removed, then the inside of the body is drawn; the loose print shown at *A*, Fig. 2, coming along with it. The body pattern is next drawn out, and then the middle box is removed. The part of the pattern *C* can then be lifted off, which enables the core *L*, Fig. 10, to be taken away. This relieves part *D* of the pattern, which is then removed.

In Fig. 11 is shown the box in which the cornice lightening core is made. The box is made in two parts with male and female joints around the rim. When the core is fixed onto the top of the body core the second series of operations is complete. The whole of the mold is now blackened and finished ready for drying in the usual way.

The next operation is to replace the parts in their respective positions. The left hand of Fig. 10 shows the parts assembled and the mold ready for filling with molten iron. The pouring gate is arranged so that the metal can be run in at the edge of the cornice through five small gates, as shown in section to the right of Fig. 10, and in plan in Fig. 12.

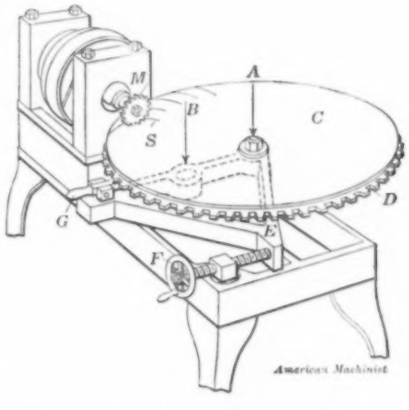
Milling Slots for Turbine Blades

In the accompanying line cut is shown a converted machine used for milling curved eccentric slots for steam-turbine blades.

Disk *C* is the work, one side of the turbine runner. This is mounted upon the index disk *D*, having index teeth controlled by the latch *G*. The work and the index disk rotate on the center *A*, which is located on the frame *E*. This latter is centered on the machine bed at *B*, about which point it is caused to rotate by the handwheel *F*. Latch G is also located on frame *E*.

When the machine is operated, the work is fed under the milling cutter *M* by turning *F* by hand, cutting a slot *S*, which is an arc of a circle about the center *B*.

Reversal of handwheel *F* carries the work out from under the cutter, and then by turning the index plate and work the required number of teeth, and locking with latch *G*, the position of the next arc slot is located. Again operating handwheel *F* feeds the work to cut another arc slot, and so on, around the entire disk. When all the slots have been cut, two disks are properly spaced, the curved



Milling Slots for Turbine Blades

buckets inserted and locked in place, and when mounted upon a shaft, forming the completed turbine runner.

Although the sketch is not accurate as to details, the principle is readily seen. It is of interest chiefly in that it shows a machining process in the comparatively new and rapidly growing field of steam-turbine work.

This illustration is reproduced through the courtesy of the Terry Steam Turbine Company, of Hartford, Conn.

Cutting Properties of Tool Steel—II

By Edward G. Herbert *

Charts that are plotted from cutting tests made with tools that are hardened and then drawn at various temperatures; tools hardened with numerous cooling methods.

Some tests for hardness and toughness, and the conclusions drawn therefrom.

*Director, Edward G. Herbert, Ltd., Birmingham, Eng.

Effect of Carbon Contents

The purpose of the next series of tests was to determine the relation between the carbon contents and the durability of steel. A series of specimens of varying percentages of carbon were prepared and analyzed by Mr. Brearley. They were all treated alike by quenching in water from 1435 degrees Fahrenheit, and they were not tempered. The percentage composition of each steel is given beside the corresponding speed curve in Fig. 10.

A comparison of this series of curves with that in Fig. 8 reveals a striking similarity. Curves *A*, *B* and *C* are characteristic of the dead-hard, high-carbon steel. In curve *D* the peak is thrown very much to the right. In this respect and in its general form it resembles curve 260 degrees, in Fig. 8.

In *E* we see the development of a first peak and in *F* this peak increases in size, while the second shrinks (compare curves 270 and 285 degrees, in Fig. 8). In *G* we have a single peak far to the right. In shape and position this peak seems to correspond with the second one in *F*, but analogy with curve 390 degrees, in Fig.

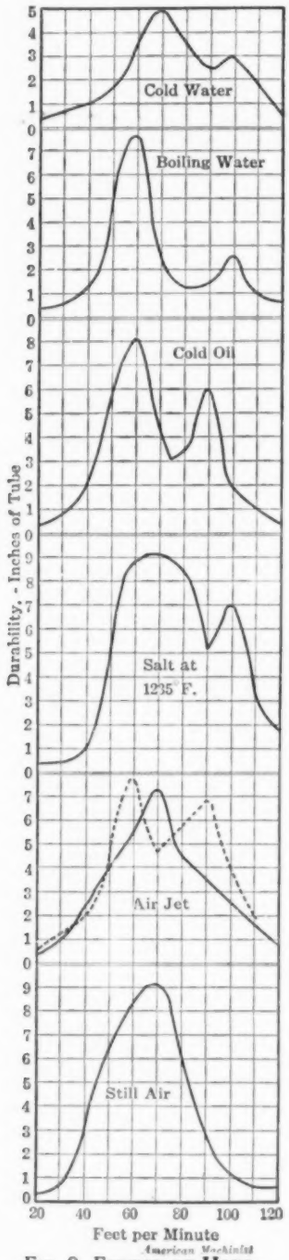


Fig. 9. Effect of Hardening Process on Durability of Tungsten-Vanadium Steel

Analysis				
Carbon	Silicon	Manganese	Sulphur	Phosphorus
1.18	0.13	0.33	.024	.016
1.17	0.11	0.27	.016	.040
1.13	0.11	0.21	.019	.019
1.08	0.14	0.34	.019	.016
0.94	0.14	0.32	.019	.014
0.86	0.11	0.19	.020	.031
0.67	0.15	0.18	.019	.022
0.62	0.16	0.13	.019	.018

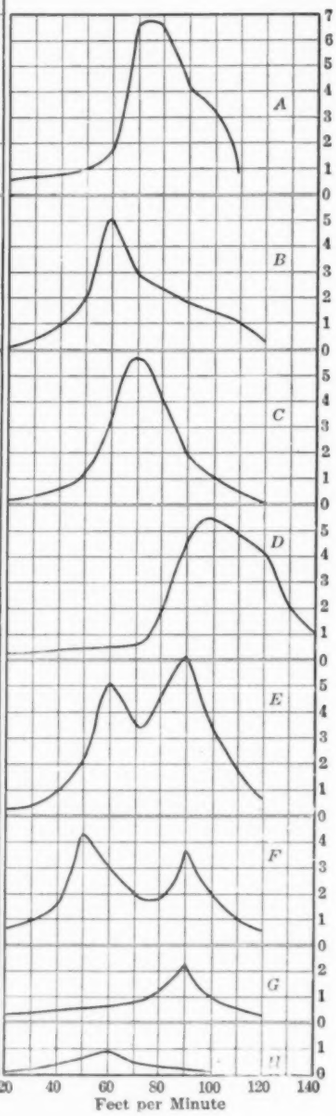


Fig. 10. Effect of Carbon Content on Durability of Carbon Steel

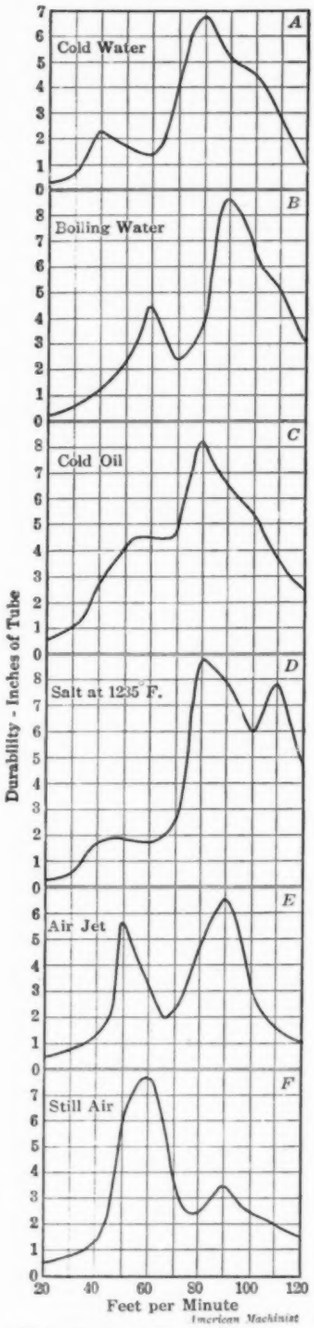


Fig. 11. Effect of Hardening Process on Durability of Tungsten Steel

8, and with 400 and 525 degrees in Fig. 7, suggests that this may be the surviving, first peak moved to the right.

In *H* the single peak again moves to the left as do curves 435 and 525 degrees in Fig. 8.

Lessons Drawn from Chart

Without further experiments it would perhaps be unwise to build too much upon this similarity between the two series, but we have some grounds for believing the similarity is not merely a coincidence.

The effect of tempering steel is to convert some of its hardening carbon into pearlite, and the temper of the steel depends on the amount of hardening carbon that remains unconverted.

The curves in Fig. 8, therefore, represent the durability of steels containing a gradually decreasing percentage of hardening carbon. But the tools which produced the curves in Fig. 10 also contained a gradually decreasing percentage of hardening carbon, for these tools were not tempered, therefore, the whole of their carbon was in the form of hardening carbon. It seems natural to infer that the corresponding curves in the two series were produced by tools containing the same or nearly the same percentage of hardening carbon.

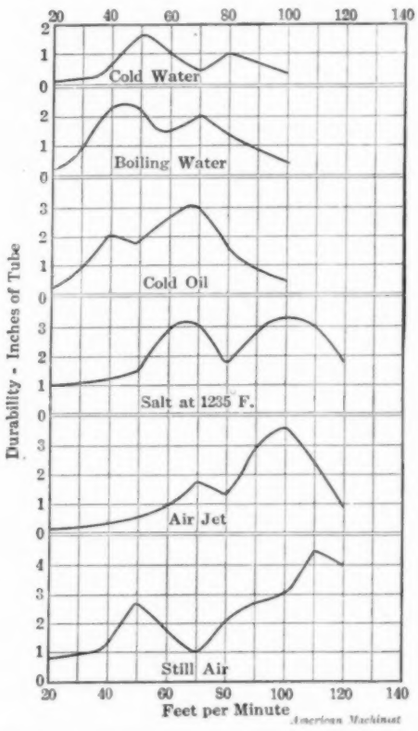


Fig. 12. Effect of Hardening Process on Durability of Tungsten-Vanadium Steel

A further inference would be that the double-peaked curve is characteristic of carbon steels containing more than 0.8 and less than 1.0 per cent. of hardening carbon. These conclusions cannot yet be taken as established, however.

Effect of Cooling Methods

Ever since high-speed steel came into general use, there has been a great diversity in the method of hardening it. The steel makers usually issue instructions for the treatment of their steel, but users often prefer to adopt methods of their own, and no definite information has been available as to the precise effect of quicker or slower cooling on the durability of the steel.

With a view to investigating this subject a series of experiments was undertaken. Six tools were cut from the same ½-inch square bar of a well known brand of tungsten steel. The heat-treatment of these tools was kindly undertaken by S. N. Brayshaw in his double-chambered furnace.

They were all heated alike by being placed in the top chamber of the furnace at a temperature of about 1750 degrees

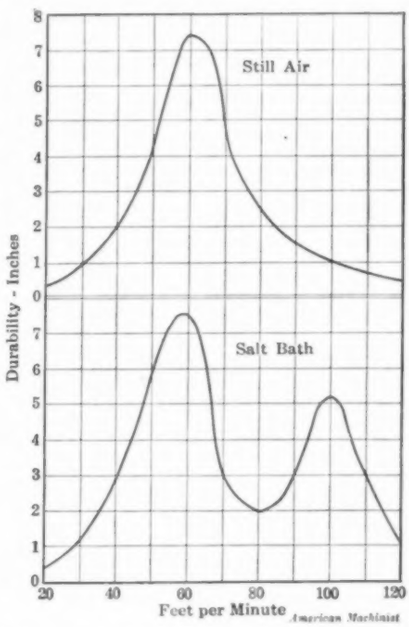


Fig. 13. Speed Curves of Tungsten-Vanadium Steel Hardened at 220 Degrees Fahrenheit

Fahrenheit. They were left in this chamber for 2½ minutes and had then attained a temperature of about 1560 degrees Fahrenheit. They were then transferred to the bottom chamber at a temperature of about 2360 degrees Fahrenheit, for 50 seconds exactly, and were subjected, respectively, to the following cooling processes: Tool *A* was stirred vigorously in cold water; tool *B* was stirred vigorously in boiling water; tool *C* was stirred vigorously in cold oil; tool *D* was stirred vigorously in fused salt at 1235 degrees Fahrenheit; tool *E* was cooled in an air jet; tool *F* was placed in wire netting and allowed to cool in still air.

Curves Produced

The tools were then tested, and the resulting speed curves are shown in Fig. 11. These curves are placed, as far as possible, in the order of slowness of cooling, but in this respect the series is not a perfectly uniform one.

Tool *C* was quenched in oil and was probably surrounded for an appreciable time by an envelop of incandescent oil vapor. Tool *D* was no doubt cooled very rapidly down to the temperature of the

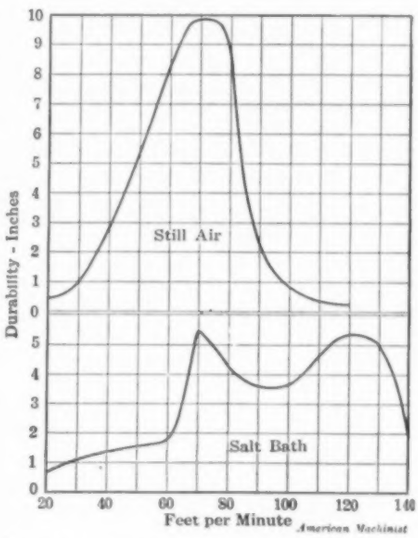


Fig. 14. Speed Curves of Tungsten-Vanadium Steel Hardened at 2350 Degrees Fahrenheit

salt bath, and this process is not strictly intermediate between the oil and the air jet; indeed, it is not certain which of the two latter processes was the more rapid.

Confining our attention for the moment to tools *A*, *B*, *E* and *F*, which are certainly in the correct order of cooling, we see that all of them gave very marked double-peaked curves. The quickest cooling, curve *A*, produces a large high-speed peak and a rudimentary low-speed peak. The rather slower cooling in boiling water increases the hight of the low-speed peak. Still slower cooling, in the air jet, causes the high-speed peak to shrink.

Analyzing Curves

In the curve of tool *F* the low-speed peak has enormously increased, and the high-speed peak has almost disappeared. The changes in the form of the speed curve follow a perfectly regular sequence. It is important to notice that the slowest cooling renders the steel most durable at the low speeds; that is, under any cutting conditions which do not generate much heat.

Returning to curves *C* and *D*, we see that with oil hardening the two peaks coalesce, and the tool has a wide range of durability at medium speeds. The salt bath, on the other hand, almost destroys the durability of the tool at the low speeds, and moves both the peaks very much to the right. This method of hardening has evidently great advantages for high-duty cutting.

In view of these results it is scarcely surprising that such conflicting and sometimes entirely misleading results are obtained from tests of tool-steel carried out in the ordinary way, on a lathe, at a single speed. If tool *E* had been tested at 70 or 80 feet only, it would have been condemned as a very poor tool, but at 50 or 90 feet the verdict would be entirely different. At 60 feet tool *F* was four times as durable as tool *D*. At 110 feet the position was exactly reversed.

Cases are known where a first-class steel, correctly hardened, has been substituted for a steel greatly inferior in

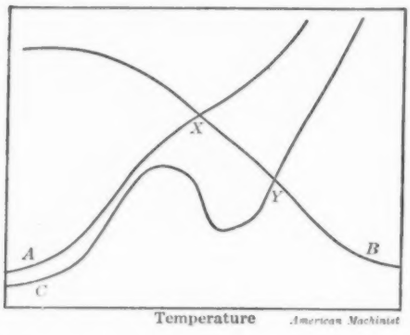


FIG. 15. TOUGHNESS AND HARDNESS

quality, and the better steel has given worse results. The working conditions, as shown by this chart, had been chosen to suit the poor steel and were quite unsuitable for the good steel.

TESTS WITH TUNGSTEN-VANADIUM STEEL

It must not, however, be assumed that the sequence of changes is identical for all high-speed steel. This is shown by the next series of curves in Figs. 9 and 12.

Both these series were obtained from the same set of tools cut from a ⅜-inch square bar of tungsten-vanadium steel. The tools were treated by Mr. Brayshaw in exactly the same manner as the tungsten tools above described, except that they were allowed to remain in the low-temperature chamber of the furnace for only 1 minute and 40 seconds, and in the high-temperature chamber for 40 seconds.

The first tests of these tools gave the curves in Fig. 12, and it was a matter of some surprise that the results were so far inferior to those obtained from the simple tungsten steel. An investigation showed that in preparing the tungsten-vanadium tools very little steel had been ground away, and thus the cutting edge was very near the original outer surface of the bar. When this had been remedied by further grinding the tools were again tested and gave the curves in Fig. 9.

A comparison of the two series of curves is instructive. In some works it is the practice to use high-class expensive steels in tool-holders of the Armstrong type. The cutters are ground on the end only and the cutting edge formed on the outer surface of the bar. Figs. 9 and 12 show how essential it is to grind away this outer surface. Not less than 1/32 inch should be removed from the top face of the cutter before it is put into use.

ADVANTAGES OF VANADIUM-TUNGSTEN STEEL

The curves in Fig. 9 show that the sequence of changes is different from that in the tungsten steel. Water-cooling develops the low-speed peak most strongly. As the cooling becomes lower the high-speed peak rises. The salt bath broadens the curve considerably, and the cooling in still air produces only one peak.

Two curves were taken from the tool cooled in the air jet. The single-peaked curve was first produced, but it was noticed that as the tool was ground away by frequent sharpening, the durability at some speeds was altering. A complete curve was therefore taken from the other side of the tool, and this is the dotted curve with two peaks.

A probable explanation of this is unequal cooling. The jet was probably allowed to impinge on one side of the tool, which would be cooled very rapidly. The other side of the tool would cool more slowly, and probably this was the side that gave the single-peaked curve, similar to that produced by cooling in still air.

This is confirmed by comparing the bottom curves in Figs. 9 and 12. Both these curves were taken from the same tool, but the double-peaked curve in Fig. 12 was taken from the outer surface, which came into direct contact with the air.

On the whole the tungsten-vanadium steel shows no advantage over the simple tungsten steel. It would hardly be safe to assume that this is due to a defect in the quality of the former steel, since it is not certain that the hardening temperature was such as to give the best results.

EFFECT OF HARDENING TEMPERATURE

Some preliminary experiments have been made to determine the effect of hardening temperature on the durability of high-speed steels, and a systematic investigation of the subject is now being undertaken. In Figs. 13 and 14 are given samples of the results that are coming out.

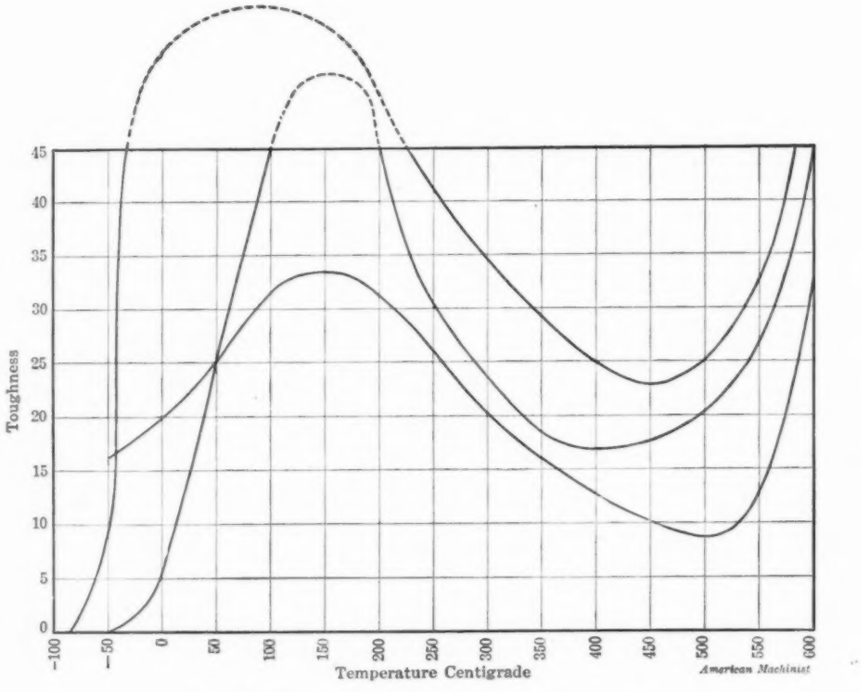


FIG. 16. CHARPY'S EXPERIMENTS ON TOUGHNESS

The experiments were made with tungsten-vanadium steel, and two methods of cooling were employed, e.i., the salt bath and still air. The curves in Fig. 13 were produced from tools heated to about 2200 degrees Fahrenheit, and those in Fig. 14 by soaking, for 3 minutes, at a temperature of about 2350 degrees Fahrenheit.

The chief interest of these curves lies in the very marked development of the high-speed peak by the use of the salt bath. In Fig. 13 the first peak remains practically unaltered in form and position, with a maximum durability at 60 feet in each case, but the salt-bath cooling produces a perfectly distinct peak at 100 feet.

The higher hardening temperature in Fig. 14 showed the low-speed peak occurring at 70 feet, and as before, the salt bath developed a high-speed peak. In this case, however, there is a great loss of durability at the lower speed, and the whole curve is moved to the right.

All the experiments so far undertaken lead to the conclusion that salt-bath hardening possesses great advantages for tools intended for the rapid removal of metal. These tools have great durability at high cutting temperatures.

Changes in Physical Properties

It remains to inquire, what are the changes in the physical properties of steel that correspond to the peculiar changes in its durability, which are exhibited in the speed curves?

It is clear that we may at the outset set aside all consideration of cutting speed. It may be taken as certain that each speed on the testing machine corresponds to a definite temperature of the cutting edge, and it has been shown that this temperature is the factor which determines the durability. We have to consider, then, what are the physical properties which render steel durable and in what manner are these properties affected by temperature?

The durability of tool steel depends on hardness and on the absence of fragility. The latter property may be termed "toughness," and it is measured on the impact-testing machine in terms of the energy absorbed in breaking the specimen by a blow.

Toughness

Glass is a typical fragile material. A tool made of glass will not keep its edge even in cutting a much softer substance, because minute portions of the edge are continually being chipped off. A fragile steel tool probably wears in a similar manner, and it is clear that a decrease of fragility will cause an increase of durability in a cutting tool.

The fragility of hardened tool steel certainly decreases as the temperature is raised above the point at which tempering commences, and there is some reason to believe that the decrease of fragility commences at a much lower temperature.

Let curve *A*, Fig. 15, represent the toughness of a tool steel, increasing with the decrease of fragility as the temperature is raised. The durability of the cutting edge will increase as the steel becomes tougher and less fragile, but only up to a certain point, for the toughening of the steel is accompanied by softening, and eventually the steel will reach a condition represented by the point *X*. Any further rise in temperature will reduce its durability by making it too soft to retain its cutting edge.

Let curve *B* represent the hardness of the steel, greatest at low temperatures and gradually decreasing as the temperature is raised. Then the durability of the cutting edge will increase from *A* to *X* as the steel becomes tougher, and decrease from *X* to *B* as it becomes softer. The curve *AXB* is the single-peaked "speed curve" of the steel.

But what of the double-peaked curves? We can only account for them by supposing the toughness to increase to a maximum, then decrease, and again increase as represented by curve *C*. If this takes place the steel will have a double-peaked speed curve, *CYB*.

Changes in Toughness

Unfortunately there appears to be no published information relative to the changes in the toughness or fragility of hardened steel at increasing temperatures. Some experiments have, however, been made with soft steels by M. G. Charpy, director of the Forges St. Jacques de Montluçon.

The experiments were made by breaking notched specimens of steel, which had been heated to known temperatures, by means of a blow from a heavy pendulum. A calculation was made of the energy absorbed in breaking the specimen and this was a measure of the toughness of the steel.

The results of M. Charpy's experiments are given in Fig. 16, and it will be seen that the curve of toughness resembles the hypothetical curve *C* in Fig. 15.

It would, of course, be unsafe to assume that the behavior of hardened tool-steels is similar to that of the soft steels used by M. Charpy, but the form of the double-peaked speed curve suggests that some such changes may take place. The loss of durability after passing the summit of the low-speed peak can scarcely be due to a softening of the steel, since it would not then be likely to recover its durability at a higher temperature, as indicated by the rise of the high-speed peak.

This first loss of durability, however, may be due to an increase of fragility occurring at certain temperatures. The question can only be settled by experiments on the fragility of hardened steels, preferably steels which give the double-peaked speed curve, and such experiments will be undertaken in the near future.

Materials for Automobile Parts

Editorial Correspondence

The comparative strength of sheet steel, steel castings and manganese bronze for such automobile parts as spring clips, brackets, etc.

Data from leading makers in the different lines.

Designers of automobiles are confronted by the problem of selecting the proper material for such parts as wheel-hub plates, spring clips, brackets, etc. The strength, methods of working and the cost must all be considered.

At the suggestion of a designer we have secured information regarding the strength of sheet steel, such as is used in pressing up various parts, of steel and of manganese-bronze castings.

We are indebted to the firms named for the information in regard to the different metals.

Pressed-steel carriage parts made for the ordnance department of the United States army, drawn from plain carbon-steel sheets, were required to have an elastic limit of 45,000 pounds and a breaking strain of 65,000 pounds. Steel frames made of a nickel alloy gave 60,000 to 65,000 pounds elastic limit and 90,000 pounds breaking strength. These were made by the Bethlehem Steel Company, which has since discontinued the manufacture of sheet material of this kind.

Steel castings have improved wonderfully in the last few years, but cannot give the impossible results sometimes expected. The designer should have some knowledge of the foundry so that the part to be made will be designed to allow the foundryman to take care of shrinkage and internal strains. When this has been done and the casting carefully annealed to remove strains, good results can be expected.

Many tests referred to by both the Reading Steel Castings Company, of Reading, Penn., and Isaac G. Johnson & Co., Spuyten Duyvil, N. Y., give the elastic limit at from 37,000 to 38,000 pounds per square inch with the tensile from 70,000 to 75,000 pounds. The elongation in 2 inches varies from 20 to 32 per cent. and the reduction of area from 30 to 53 per cent.

The William Cramp & Sons Ship and Engine Building Company, Philadelphia, Penn., gives some interesting results from Parsons manganese bronze, the test section being 2 inches long. For castings

the elastic limit runs from 40,000 to 46,000 pounds per square inch, while for rolled material the elastic limit is 50,000 pounds.

For total tensile strength the castings lead with 74,750 to 78,000 pounds per square inch, as against 71,420 pounds for the rolled metal. Elongation runs from 29 to 36 per cent., and reduction of area from 38 to 44 per cent.

These figures are for uniform sections as with all test pieces, and do not give the exact conditions to be met with in castings of varying shapes and thicknesses. But they afford a means for approximate comparisons and may be useful to some who are debating which material to use.

Grinding Gear Cutters Internally

Editorial Correspondence

Method of locating and holding gear-shaper cutters on a magnetic chuck on the internal grinder while the bore is ground to size.

Details of a special attachment for reciprocating the grinder table on a very short stroke. How the work is mounted, finished quickly and accurately and replaced by the next cutter.

The Fellows Gear Shaper Company, of Springfield, Vermont, grinds the bore of its gear cutters (prior to grinding the teeth) on Heald internal grinders. The machines are kept constantly in operation on this work, and as the wheel traverse required in the operation is always very short, a special reciprocating attachment has been applied to the grinder by Mr. Fellows in place of the regular reversing mechanism for the table carrying the grinding-wheel head. In addition to the fact that the bearing surface to be ground in the cutter is quite narrow, the table movement necessary is further reduced through the use of a grinding wheel which is never passed completely through the work. The wheel is somewhat wider than the surface of the bore to be finished, and is simply traversed to and fro a sufficient distance to carry the leading end of the wheel past the corresponding face of the cutter. With this reduced stroke, which as a rule is perhaps not over 3/16 or 1/4 inch, the work of grinding out the bore is accomplished rapidly.

Holding the Cutter

Before describing the operation of the wheel-slide reciprocating device, it may be well to refer briefly to the method of locating and holding the cutters which are to be ground. Figs. 1 to 4 show the machine equipped with a Walker magnetic chuck and with a special locating arm for mounting the cutter. This arm is pivoted on a bracket behind the wheel head and when not in use is swung up as in Fig. 1, out of the way of the wheel. It carries at its left-hand end a pilot pin which is tapered very slightly to receive the cutter and which when run forward is centered exactly in the magnetic chuck by means of three screws shown at *A A*, Fig. 4. These centering screws are used in place of a bush, as in the case of wear they are readily adjusted again to center the pilot on swinging arm *B*.

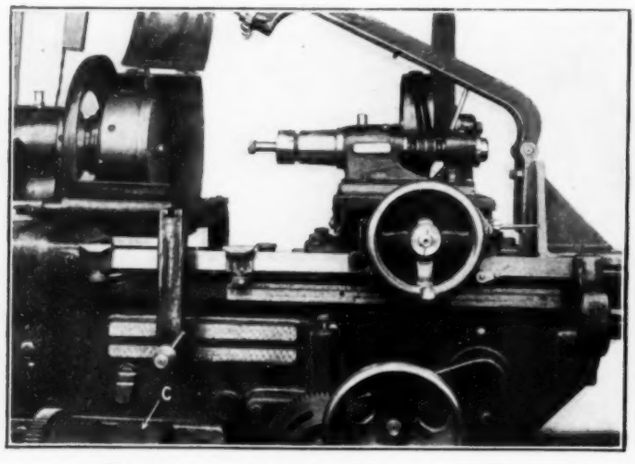


Fig. 1 Locating Gear-shaper Cutter on Magnetic Chuck on Internal Grinder

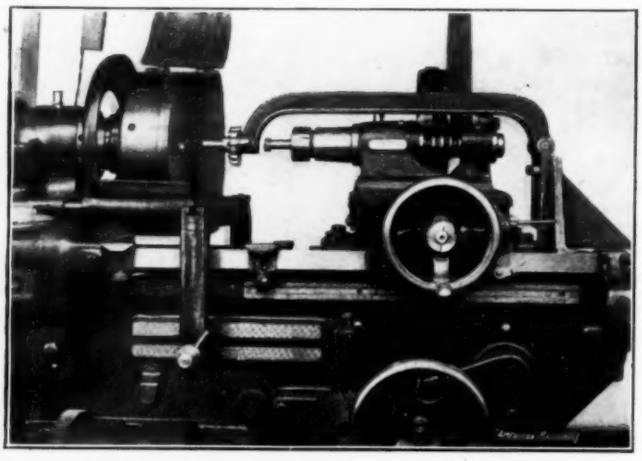


Fig. 2

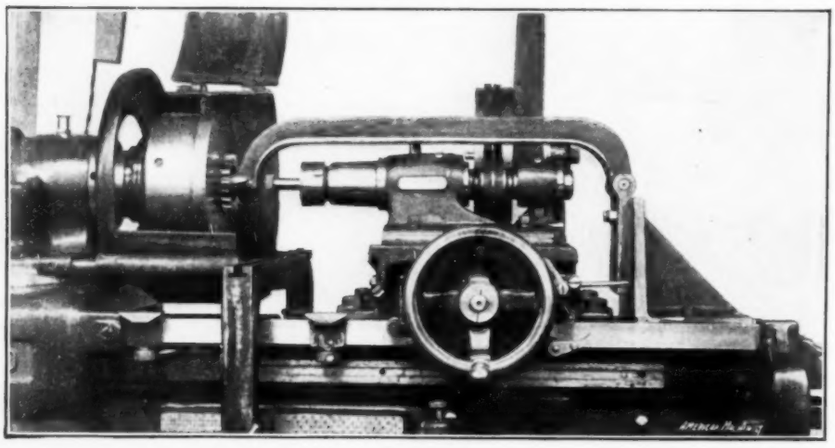


Fig. 3. The Cutter in Place on the Chuck

The cutter to be ground is placed on the arm when in position shown in Fig. 1; the arm is then swung down to the position in Fig. 2, and the table with the wheel head run forward to carry the cutter against the chuck as in Fig. 3, the pilot of course centering the cutter properly in this position. The arm is then drawn back and swung up out of the way, and the grinding operation is performed.

Reciprocating Mechanism for Table

The special mechanism applied to the grinder for moving the table and wheel

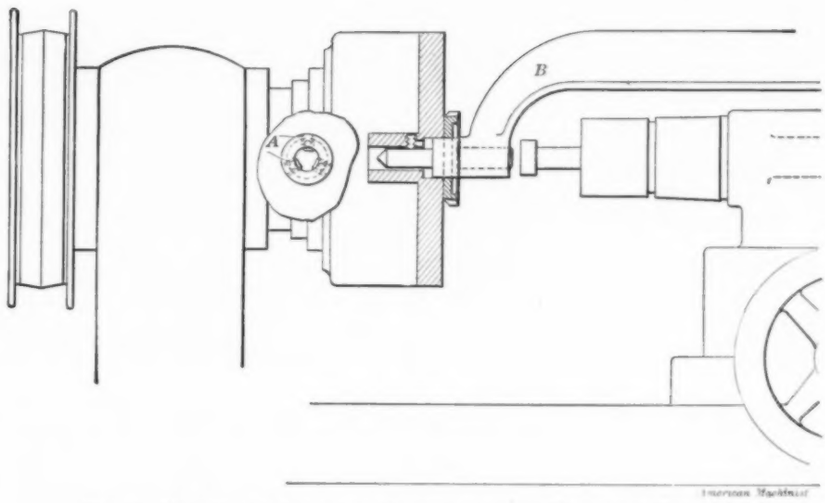


FIG. 4. METHOD OF LOCATING CUTTER ON THE MAGNETIC CHUCK

to and fro is shown in Fig. 5, and, as will be seen, it is a cam-operated attachment, the cam being shown at *C*, Figs. 1 and 5. The cam gives a positive movement to lever *D*, and the latter through link *E* rocks arm *F* back and forth and thus transmits a backward and forward movement to gear G. This gear, as shown in the sectional view in Fig. 5, operates the bevel gears through which is actuated the vertical pinion shaft for moving the table to and fro.

Rocker arm *F* and gear *G* are connected by means of spring pin *H* and toothed ring I behind gear *G*. This gear, as will be observed, meshes with a pinion back of handwheel *J*, so that by disengaging plunger *H* the table may be reciprocated by hand when desired.

VARIATION OF STROKES

The position of adjustable link *E* determines the length of stroke imparted to the table and wheel spindle, and the throw of the cam is such as to give a positive travel to the table, ranging from 0.130 to 0.500 inch. The oscillating disk *I* is adjustably mounted on the back of gear *G* and the grinding wheel is readily adjusted to the required position for the stroke desired.

THE CAM SHAFT DRIVE

The cam *C* derives its motion from the pinion and gear operated through change gears *K* at the end of the machine. These gears are driven by sprockets and chain from the driving shaft at the rear of the base. These change gears form a means by which any desired rate of travel may be imparted to the cam *C* and hence to the wheel head itself.

F. A. S.

Washington, D. C.—Acting Postmaster General C. P. Grandfield has announced the promulgation of the following Act, approved June 25, 1910, to provide additional protection for owners of patents of the United States:

"That whenever an invention described in and covered by a patent of the United States shall hereafter be used by the United States without license of the owner thereof or lawful right to use the same, such owner may recover reasonable compensation for such use by suit in the Court of Claims: Provided, however, that said Court of Claims shall not entertain a suit or award compensation under the provisions of this Act where the claim for compensation is based on the use by the United States of any article heretofore owned, leased, used by, or in the possession of the United States; Provided further, that in any such suit the United States may avail itself of any and all defenses, general or special, which might be pleaded by a defendant in an action for infringement, as set forth in Title Sixty of the Revised Statutes, or otherwise: And provided further, that the benefits of this Act shall not inure to any patentee who, when he makes such claim, is in the employment or service of the Government of the United States, or the assignee of any such patentee; nor shall this Act apply to any device discovered or invented by such employee during the time of his employment or service.

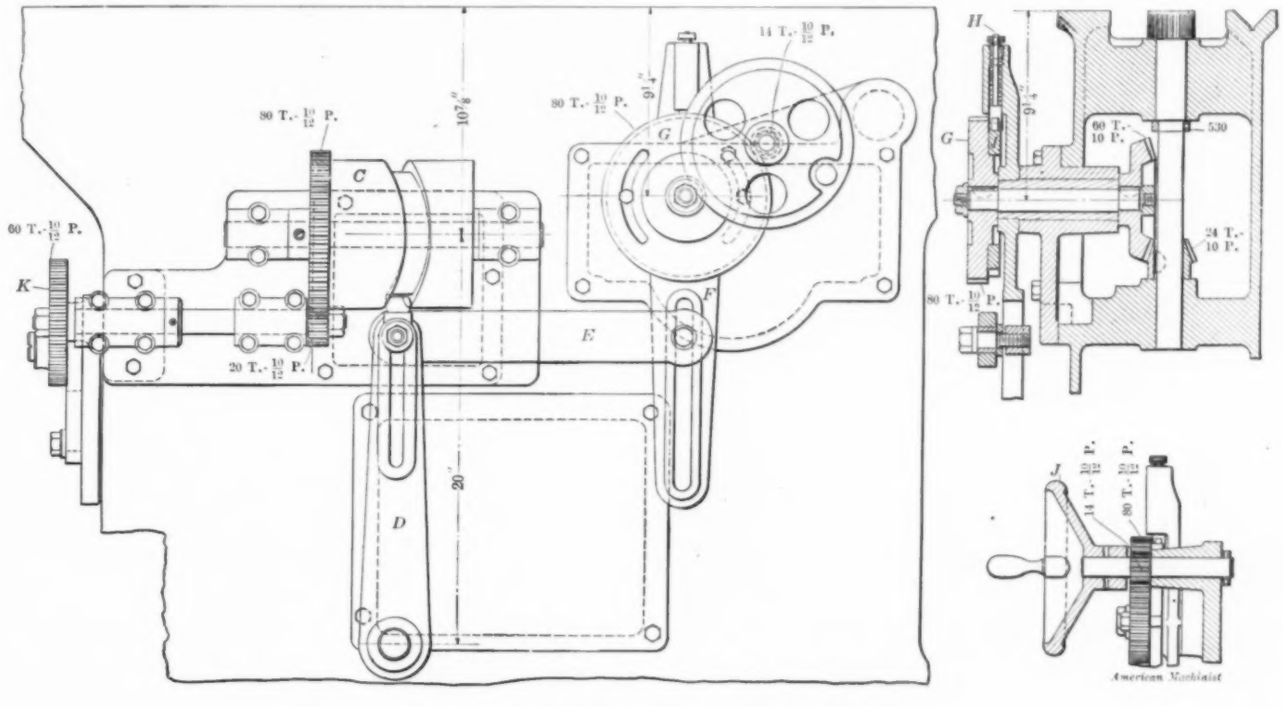


FIG. 5. RECIPROCATING ATTACHMENT FOR TABLE

Jigs for Motor Truck Engine

Editorial Correspondence

Fixtures for milling, drilling and boring parts of oil pump, magneto bevel gear case and crank case. Arbor press broaching.

Some of the milling and drilling fixtures used in the manufacture of the engines for the Morgan truck are shown in the accompanying halftones. The truck is manufactured by the Morgan Truck Company, of Worcester, Mass., but at the present time most of the machine work on the engines is being done by the Blake & Johnson Company, of Waterbury, Conn.

In Fig. 1 are shown the milling and drilling fixtures and jigs for the oil-pump casing. This pump is of the well known geared type, and the fixture shown at *A* in Fig. 1 is for the first milling of the base of the rough casting. This casting is clamped against the angle plate, which is provided with three bearing points for this purpose.

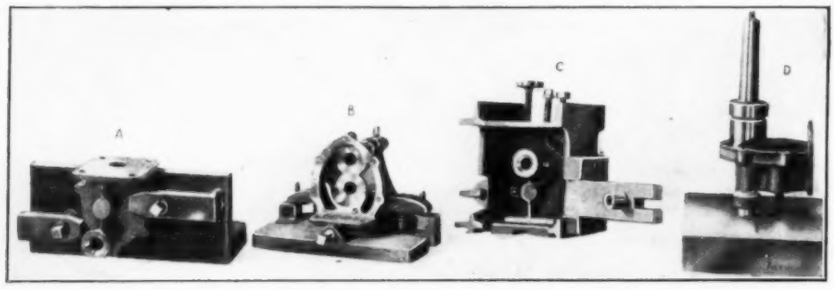


FIG. 1. MILLING AND DRILLING FIXTURES FOR OIL PUMP

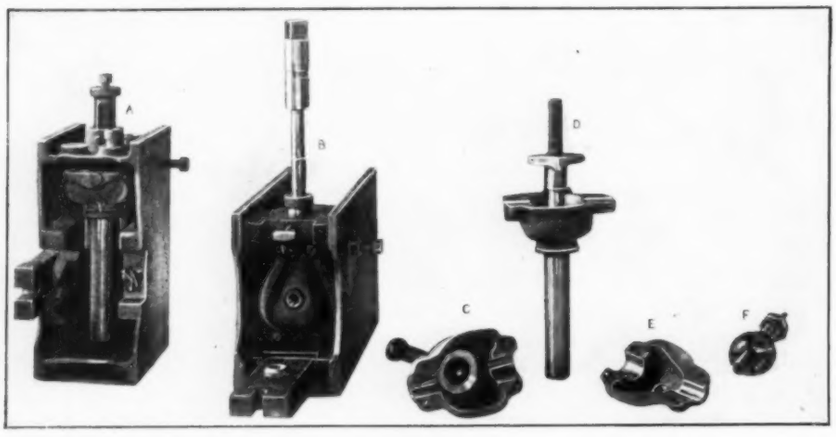


FIG. 2. FIXTURES FOR MAGNETO BEVEL-GEAR CASE

Fixture *B* is used for the next operation; the surface milled in fixture *A* is clamped down upon the base of fixture *B* and the side face of the pump casing milled across. At *C* is shown the jig, of the box type with a swinging cover, for drilling and tapping for the screws which hold the two halves together. This jig is used also for drilling and reaming the two bearings.

At *D* the casting is set upon a peg which fits one of the bearings, and the counterboring tool, which is piloted and properly stopped, is then brought down to counterbore and face for the gears.

Fixtures for the magneto bevel-gear case are shown in Fig. 2. This piece is a bronze casting, the general shape of which will be seen at *C* and *D*. At the latter point the limit gage for the facing of the bearing end is shown projecting above the casting. The first operation on this piece is to mount it in a lathe, bore the sleeve portion and face the gear seat inside of the casting body, and also the face of the casting itself.

After boring and facing, the piece is mounted upon an arbor and turned on the outside. It is then put into the fixture shown at *A*, where it is held between two lugs, and the plug latch at the top is set down into the bored portion of the gear seat. Here the drilling and tapping for the cap screws are performed. The piece is then transferred to the jig shown at *B*, and boring and reaming tools are run down through the cross bearings, the cover of the gear case first being put on. The piece is of course held in the jig by the turned sleeve portion, and the jig

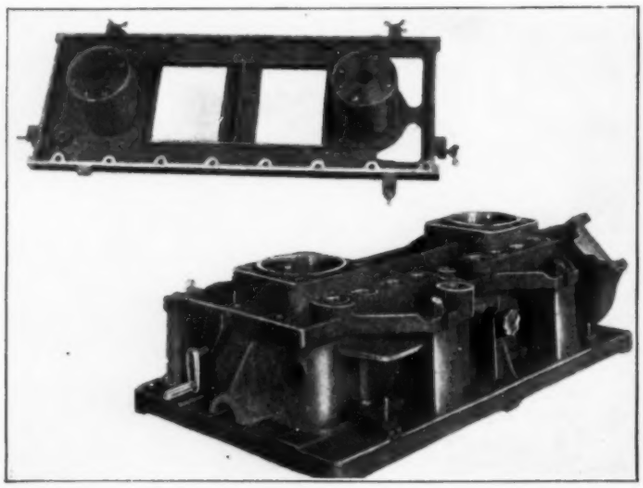


FIG. 3. BORING AND DRILLING JIGS FOR CRANK CASE

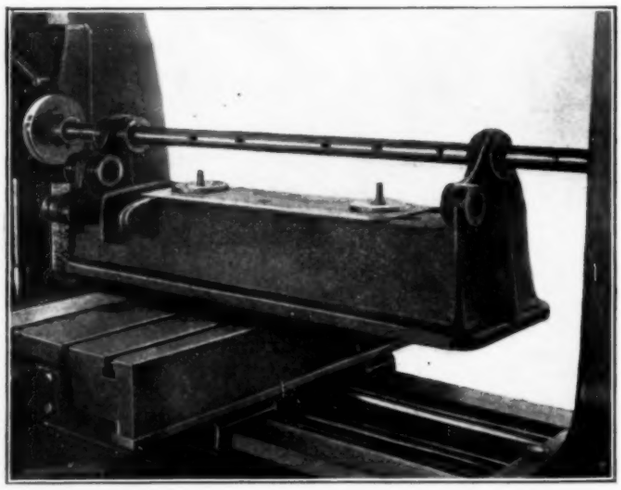


FIG. 4. FIXTURE FOR BORING BEARINGS IN CRANK CASE

insures that the boring of the cross bearings is at right angles with the sleeve. This work is done in the drill press.

As the gearing is of the bevel type, it is necessary that the seating of the gears on the facing of the bearings shall be very accurate. The facing of the cross bearing is done with the tool shown at *F*, which is first put inside the casting and the bearing cap put on and screwed in place. The facing is then done in the drill press, suitable stops being provided for location. The gage shown at *D* is then applied, which is of the "go-in" and "not go-in" type, to insure the necessary accuracy.

In Fig. 3 are seen two of the jigs used for the upper half of the crank case. The one in place on the casting in the lower portion of the illustration is for drilling and reaming the holes for the valve rods and bearings for the auxiliaries, and also for boring two of the openings for the engine cylinders. This is also drill-press work. These two openings are bored for purposes of alinement only, and the two middle openings for the other two of the four cylinders of the engine are left in the rough.

When this work has been done, the casting is turned over and the jig shown in the upper portion of the halftone is put upon the other face of the casting. The two projections on this upper jig, which have hardened and ground faces, then fit into the two bored cylinder openings in the crank-case casting, and thus the stud holes around the flange of the casting are located.

Fig. 4 shows the fixture for boring the main bearings, the countershaft bearings and the bearings for the pump, magneto, etc., of the crank case. Here the two locating bosses are seen, these fitting into the two bored openings for the engine cylinders already spoken of.

Rather an interesting operation is shown in Fig. 5. This is the broaching of the keyway in the centrifugal water-pump runner. It will be seen that this work is done in an ordinary arbor press. The bar of the broach is of drill rod, the diameter of the bore of the pump runner, and has inserted teeth set along one side. These teeth are the same width all the way up the broach, but are of increasing depth from the lower end toward the top. In this way the keyway is broached out by one passage of the tool through the casting.

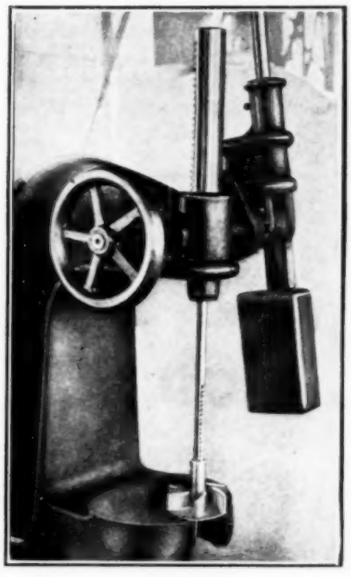


FIG. 5. BROACHING CENTRIFUGAL PUMP RUNNER ON ARBOR PRESS

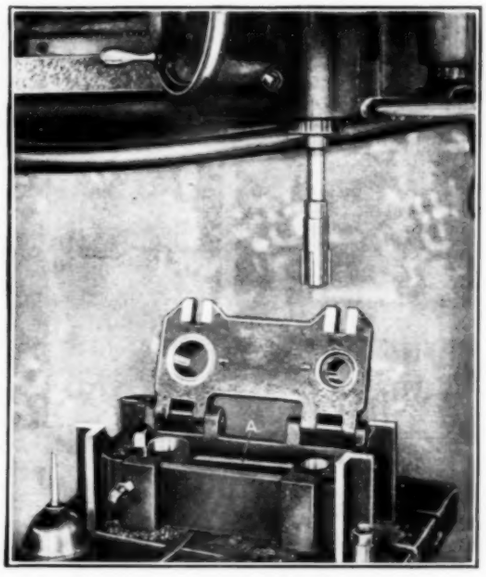


FIG. 6. BORING AND REAMING CONNECTING-ROD ENDS ON RADIAL DRILL PRESS

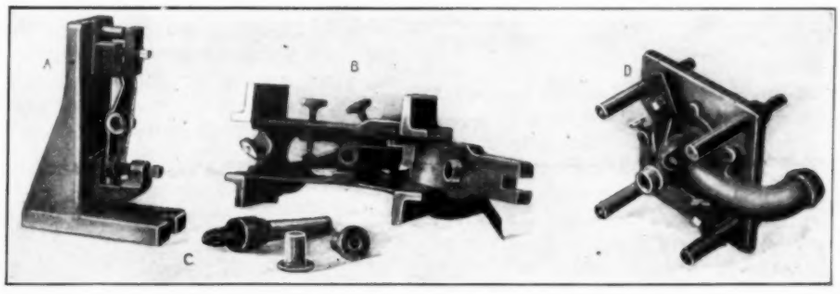


FIG. 7. JIGS FOR ROCKER ARM AND WATER PUMP CASE

Boring of the connecting-rod ends is shown in Fig. 6. The most interesting part of this box jig is the piece *A* shown in the figure. This piece is not a part of the connecting rod, but is a square bar having projecting points on its bottom face at each end. The two set screws shown in the cover of the jig clamp this bar down upon the connecting rod, and by the projecting points on the bar all of the clamping strain put upon the rod is brought near the two ends, where it is supported in the jig. Thus springing of the rod is avoided and the two holes in the ends are bored and reamed perfectly true.

At *A* in Fig. 7 is shown the fixture for straddle milling the faces of the bearing of the rocker arm; while at *B* the fixture used for boring and reaming this bearing is shown. In this latter fixture also, the cup at the end of the rocker arm is bored out by the ball tool shown at *C* in Fig. 7. It is this cup-shaped depression into which the top of the valve push rod projects.

At *D*, in the same figure, is shown a fixture for holding a rather awkwardly shaped piece. This is one half of the centrifugal pump casing and the jig shown is for the purpose of drilling and tapping the screw holes around the periphery, the four legs serving to support the irregular casting free from the drill-press table.

Cutting Two Gears on One Machine

Among the appliances illustrated in an article on the regeneration of the old shop, published in the AMERICAN MACHINIST, at page 335, Vol. 31, Part I, there was shown an attachment for cutting two gears at once on a Brown & Sharpe No. 13 automatic gear cutter in the S. A. Woods Machine Shop, of Boston. This appliance proved so successful on trial in one shop that all of the No. 13 machines, to which this attachment is particularly adapted, were equipped in the same manner. They were found to be excellent for blocking out bevel gears and were used for that purpose only. There is no provision made for taking up backlash in the gears connecting the main to the auxiliary spindle. Therefore, the attachment could not very well be depended upon for a finishing cut.

It is apparent that the actual cutting time will be cut in one-half by the use of this attachment, but as the time required to replace the gears on the work arbor is the same for each gear, the output per day is not in that proportion. On one particular size of gear this attachment raised the daily output from 50 to 90 gears, which is surely sufficient to warrant the small outlay.

Letters from Practical Men

Concerning the details of making things in machine shops, from the first sketch to the shipping room.

A letter good enough to print is good enough to pay for. The value is in the idea—not the length of the letter.

Tool for Rounding Ends of Pins

The sketch, Fig. 1, shows a tool for rounding the ends of small pins, which I have found very handy, and as it is so very easy to make I thought it might be a good kink for others. Generally, in order to round the ends of small pins, they are put in a speed lathe and filed, which is slow work. I take a piece of drill rod and drill a hole through it (the size of the stock to be rounded) on an

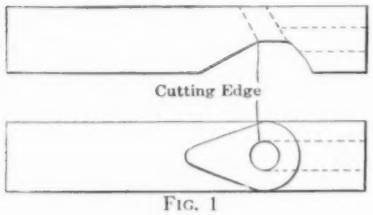


FIG. 1

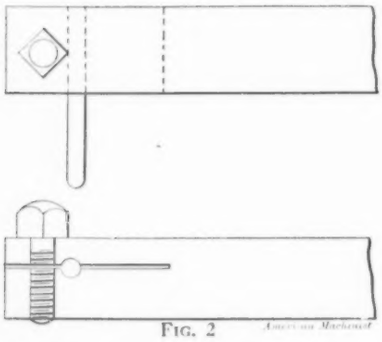


FIG. 2

TOOLS FOR ROUNDING THE ENDS OF SMALL PINS

angle, which gives me clearance, then drill a hole in the end of a tool the size of the stock to be rounded. I now grind out one side, as in the sketch, to the center of the tool, and harden and the tool is done.

For holding the stock a chuck is made out of a square piece of scrap as shown in Fig. 2.

The tool is used in a small drill press.

Chicago, Ill. FRED J. BLUM.

Perpetual Inventory System

Many purchasing agents and storekeepers have felt the great necessity of having some simple system of perpetual inventory to guard against a depletion of stock of any class of material before order is placed and well on the way for new lot.

The following is a brief description of such a system which answers every requirement in that it is simple, comprehensive and does not take much time to keep up.

A durable loose-leaf binder is used to hold the record sheets, which are 5½x8½ inches, and ruled as shown in Fig. 1. Each sheet bears a consecutive number, this number corresponding to the number assigned for the article referred to on the sheet, said number being also the one marked on the drawer, bin or rack in which the article is stored, as a means of quick location. To aid further in quickly locating desired information the sheets are filed in the binder alphabetically.

This record is in charge of the stock clerk, who reports to the purchasing agent when stock reaches a certain point as indicated on each sheet.

When supplies are wanted in the shop, the foreman of the department issues an order on the stock clerk, as shown in Fig. 2, who delivers the required articles and charges them against the item on the proper inventory sheet. When a

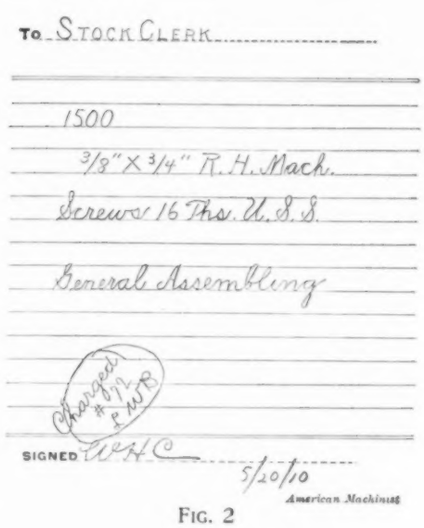


FIG. 2

sheet is filled up, it is removed and filed in the permanent binder, and after two years it is destroyed.

This system is recommended to all purchasing agents, and those who use it will find that it more than repays the little time and trouble incurred to keep up the record.

New London, Conn. L. G. STEBBINS.

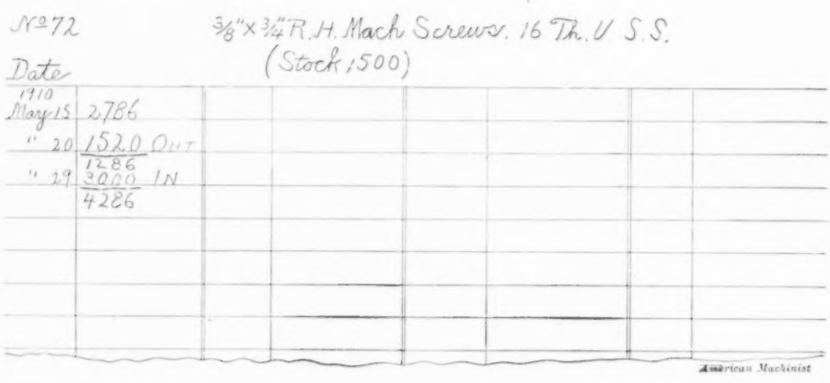


FIG. 1

How a Small Shop Cut a Pair of Special Gears

One day a customer brought into the shop a pair of eight-pitch spiral gears, both right-hand lead, one having eight teeth cut at an angle of 60 degrees and the other having sixteen teeth cut at a 30-degree angle. He wanted to replace them with a pair of the same pitch, but having an equal number of teeth, and he wanted them in a hurry.

The "super" had gone away to demonstrate a machine; the draftsman was sick; and as the foreman had forgotten how to calculate the number of teeth and the lead of the spiral, he passed around to

some of the "old-timers" who looked wise, but couldn't help him.

Finally one of the younger generation dug up a catalog from a pile of rubbish and after looking through it, discovered that if the diameters of the gears are the same, and the number of teeth in each of the wheels the same, the spiral angle is 45 degrees.

This was something to work on at any rate, and interest was revived again. Presently one of the toolmakers spoke up and said that it stood to reason that inasmuch as 45 degrees was the mean between 30 degrees and 60 degrees and that twelve was midway between eight and sixteen, it might be worth while to try and see how it came out. This was all very fine until the milling-hand wanted to know what the lead of the spiral was. Again we scratched our heads and looked wise, but finally, however, one of the men who attended night school occasionally remembered that a 45-degree triangle has two of its sides equal and by considering the circumference as one side and the lead as the other, we soon had the required lead.

Here we slipped up again, as we used the outside diameter instead of the pitch diameter; however, the error was observed in time, and it was but two hours later that our much-gratified customer had the gears on the machine, and in response to our telephone inquiry his reply was: "They are slick."

Brooklyn, N. Y. W. E. McA.

Machining a Large Hammer Frame

The accompanying halftone shows a planing operation on the side frame of a 20-ton steam hammer manufactured at the plant of the Morgan Engineering Company, Alliance, Ohio. The hammer of which this side frame is a part is probably the largest of its type; the anvil weighing 500 tons and the hammer proper 250 tons. The steam cylinder is 44 inches in diameter and 96 inches stroke. Three of these hammers were shipped to Taylor Brothers, of Manchester, England, for use in manufacturing steel tires.

Alliance, O. C. C. Howe.

A Stand for Drawings

Nearly all draftsmen have to refer to drawings while at work, and they do not like to be constantly getting up from their seats for this purpose, so therefore, this idea should be useful.

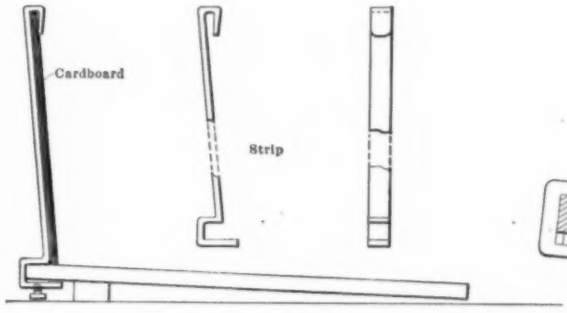


Fig. 1

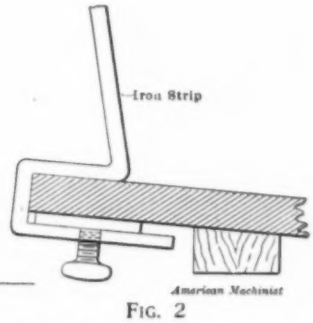


Fig. 2

Reference Stand for Drawing Board

The stand is very simple and easy to make, and fix to the drawing board. It consists of a piece of cardboard or wood, the same size as the drawing boards, and two strips of iron, one at each end of the cardboard and bent as shown in Fig. 1, so that they can be fixed to the drawing board. The small screws are to fasten the strips tightly to the board. A small strip is placed between each screw and the board. The reference drawings are pinned to the cardboard, and the draftsman has all in front of him. When the day's work is over the cardboard, with all the drawings on it, can be taken from the strips, and placed on the drawing board ready for the next day. Fig. 2 is a detail of the lower end of the iron strips.

Oscar A. Meisenheimer.

Coventry, England.

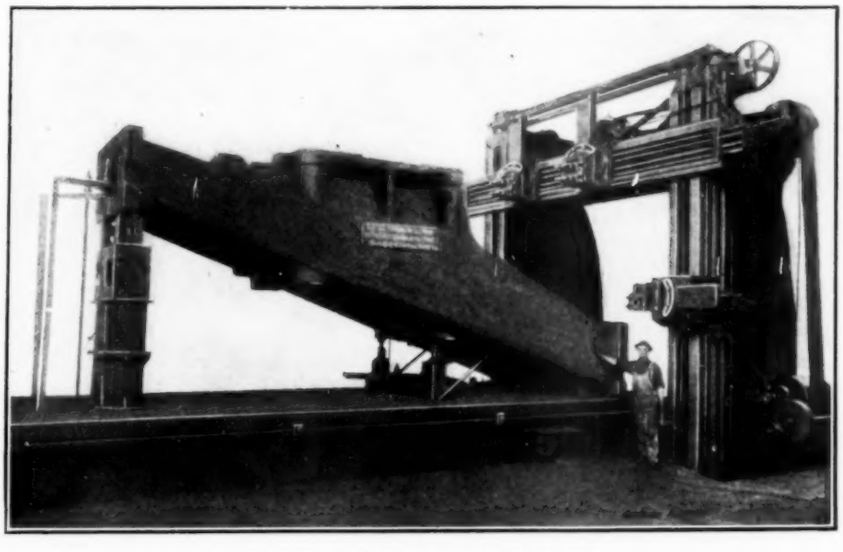
Drilling Glass

I should like to submit the following method to you for drilling glass, which I have found much quicker and accurate than other methods often used.

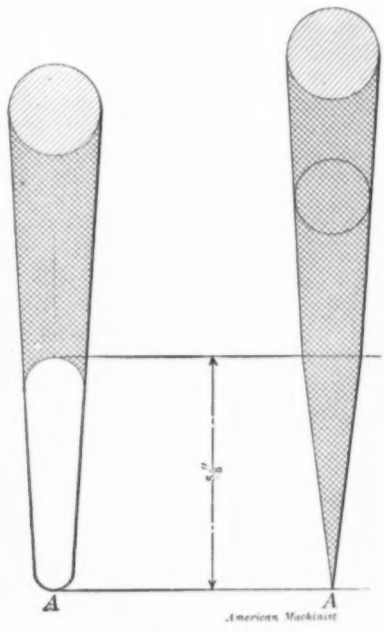
First procure a 6- or 8-inch round file and grind, as shown in the sketch. The edge *A* should be kept sharp by the use of an oil stone and great care should be taken not to draw the temper of the file in grinding.

For a lubricant, use a solution of 1 part camphor, 1 part ether and 2 parts turpentine.

The drill should be kept wet with this solution, and should be turned *backward*; otherwise the screw-like arrangement of



Planing a Large Hammer Frame



Drilling Glass

the teeth of the file will cause it to draw in, and the glass will be shattered.

After the hole is once through, the wet file may be used as a reamer, and by inserting a large file any sized hole may be drilled.

MAURICE C. CLARK.

Claremont, N. H.

Boring the Spindle Bearings of the Landis Grinder

Fig. 1 shows the jig and tools for boring the self-alining spindle-bearing boxes of the Landis grinder. Reference to Fig. 2 shows the construction of this particular piece. As the radius *A* varies

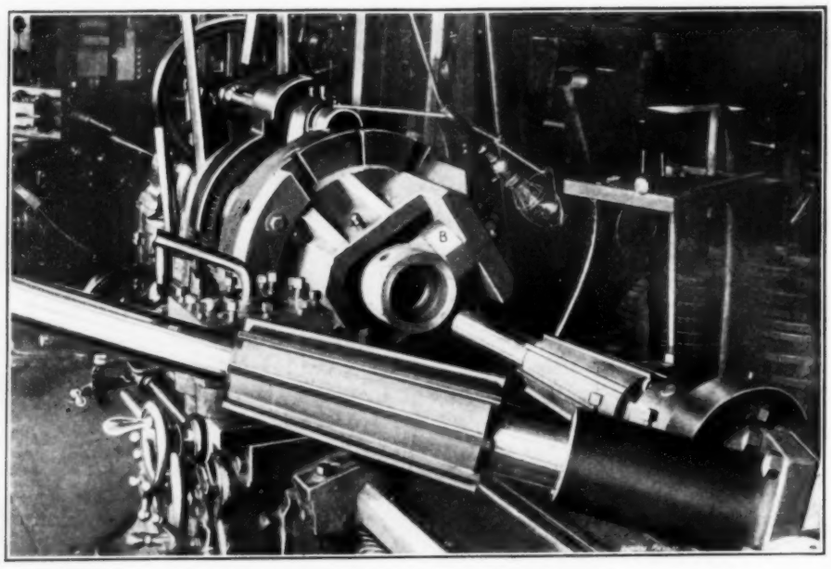


FIG. 1. THE WORK IN THE LATHE

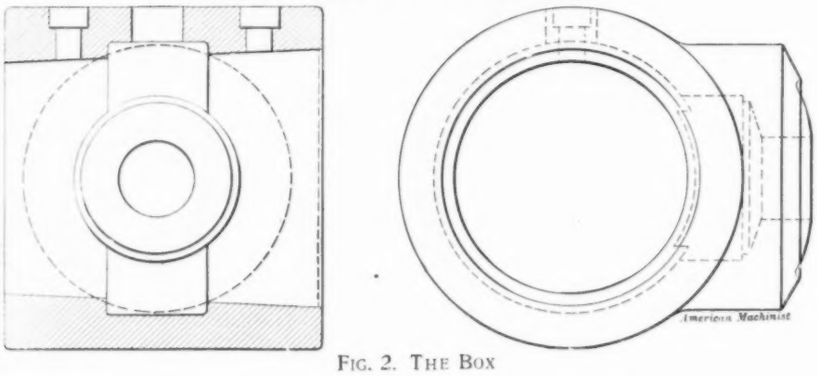


FIG. 2. THE BOX

in the different sizes of machines, the jig is provided with a suitable-sized fill pieces as shown at *B*, Fig. 1. These are fastened with cap screws not shown. Set screws are also provided to support the work at the rear end.

A boring bar (not shown) provided with two cutters is used for roughing, each cutter leaving sufficient stock at its respective end of box for the roughing and finishing reamers. These reamers are of heavy construction, being also provided with pilots.

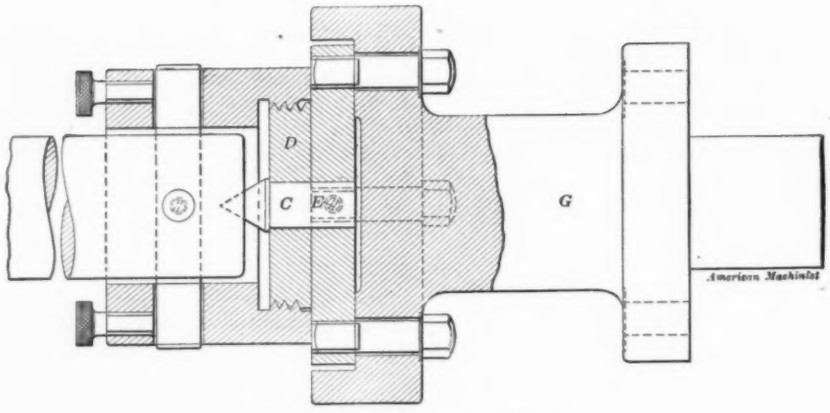


FIG. 3. FLOATING REAMER HOLDER

To insure that the finishing tool reams the work true to its own taper, a floating holder, as seen in Fig. 3, was designed. The center *C* is a press fit in disk *D*. The head *G* is bored to give the disk suitable play for adjusting with three headless screws *E*, spaced equally in *G*. To secure the desired alinement, a bar provided with an indicator is chucked and revolved around the point of the center; adjustments are now made with the three screws as before stated, after which the four cap screws are securely tightened.

The reamer is prevented from digging in by the two thumb screws shown.

ULRICH STEINER.

Waynesboro, Pa.

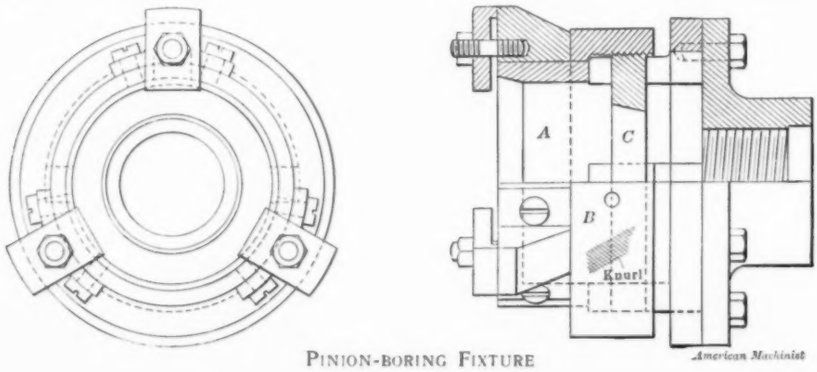
Boring Pinions

We machine a great many steel gear and pinion castings and the accompanying sketch of a boring fixture may interest some who do similar work.

The pinion is placed in body *A* and lightly clamped. The spider ring *C* is backed off by sleeve *B* before the pinion is placed in the fixture. Sleeve *B* is then turned to bring spider *C* up tight on the teeth of the pinion and the clamps are tightened down. The machine work then proceeds.

The reason for making spider ring *C* movable, was due to the inaccuracy of the pinions caused by rapping the pattern.

Oil City, Penn. JOHN REID.



PINION-BORING FIXTURE

Discussion of Previous Question

Letters from our readers showing how many men of many minds look upon various subjects opened up in previous numbers.

Calibration of Pyrometers and Use of Lead Bath

C. U. Scott in the AMERICAN MACHINIST, Volume 33, Part 1, page 791, attacks very strongly two of my previous articles on the melting points and freezing points of pure metals and salts.

In the first place, I must ask him to acquit me of having intentionally misquoted him, as the melting point and freezing point of sodium carbonate are practically identical. In his article in Volume 32, Part 2, page 1078, he practically admits this, and also says:

"I then determine the correction from observing the solidification, taking the readings when it is solidified. In this manner I get readings in three different ways, and note their correctness. However, I rely on the one taken as the liquid solidifies. At any time that there is much of a variation in the three heats I repeat the entire operation in order to note where I have erred."

In this same article he says that his sodium carbonate must be chemically pure. If it is chemically pure then its melting point must be definite, and can only be lowered by impurities, and the differences he has observed are not necessarily due to the process of manufacture, as he suggests.

I note with pleasure that he appears to fully appreciate the fact that great care must be taken when using sodium carbonate for calibration purposes, but I would emphasize the danger of a very small amount of impurities lowering the melting point considerably. One per cent. of sodium sulphate lowers the melting point nearly 18 degrees Fahrenheit.

Mr. Scott complains of writers misquoting him, but he has misquoted me as saying that the melting point of antimony is 1159 degrees Fahrenheit, whereas the figure I gave was 1169 degrees Fahrenheit. He then attempts to correct every melting point given in my first article, and remarks: "The reader will readily see why I did not refer to his article from the above facts."

Now let the reader look at these facts:

Temperatures given by.	C. U. Scott. Fahrenheit.	W. H. D. Fahrenheit.
Tin	455	449
Zinc	842	787
Antimony	1150	1169
Aluminum	1157	1214
Silver	1749	1763

The slight difference in the temperature given for tin is hardly worth mentioning. The slight difference in the temperature given for silver can perhaps be explained by the fact that I gave the temperature obtained by using a reducing atmosphere, whereas Mr. Scott may be simply determining this point in *air*. As to the other variations, in my opinion, Mr. Scott cannot have been using pure metals, or otherwise the authorities, to whom he refers, but omits to name, must be at fault.

The following are the melting points of the above metals which are recognized by the authorities here in England, and all over the Continent, among whom I may mention Dr. J. A. Harker, of the National Physical Laboratory, London:

	Fahrenheit.
Tin	449
Zinc	787
Antimony	1169
Aluminum	1214
Silver (in air)	1751
Silver (in reducing atmosphere)	1763

Perhaps Mr. Scott, in using these metals, has not taken sufficient care to preclude any admission of air, and the subsequent oxidation of the metals. Most of them are capable of dissolving their own oxides, and thereby altering, very considerably, their melting points.

Again, on page 791, he states that I referred to salt as an excellent metal, when what I did say was that "some salts of metals meet almost every requirement," and gave as an example ordinary table salt.

He also states that the melting point of sodium chloride is 1421 to 1426 degrees Fahrenheit against my figures of 1463 to 1472 degrees Fahrenheit. I need only say in reply that the authorities previously mentioned give 1472 degrees Fahrenheit plus or minus 4 degrees as the melting or freezing point of this salt. It is, however, pleasing to note that Mr. Scott says he uses sodium chloride and finds it superior to sodium carbonate.

As to his criticism of my method of using a piece of 0.90 per cent. carbon tool steel as a check on the correctness of a pyrometer, I will only repeat that I have found this method highly satisfactory, and can safely recommend it. If he will only adopt the same, it will save a great deal of time and inconvenience, and shed light on many of his present difficulties.

Mr. Scott says that his idea in presenting this subject to the readers of the AMERICAN MACHINIST was for the purpose of bringing out a standard method of calibrating. This is a very good idea, and would, no doubt, be useful to many, but we should first make sure of the accuracy of our melting temperatures and the purity of our materials. Unless such a course is adopted serious difficulties will be encountered.

Mr. Scott then writes two columns on methods of overcoming the high specific gravity of lead, its tendency to stick in cavities and between teeth, the rapidity with which it is oxidized, and the ease with which it dissolves its own oxides and sulphides, etc. All these are disadvantages of the lead bath, which were pointed out by me, when comparing it with the salt bath. Seeing that Mr. Scott gives methods of overcoming them, he presumably admits their correctness.

The time and money spent in cleaning the lead bath, and keeping a reducing atmosphere on the surface, should alone be sufficient to condemn it, apart from the fact of its low melting point, as compared with that of the salt bath. Mixtures for salt baths can be made with a melting point that agrees with the critical point of any steel to be hardened, and they can therefore, be used as a pyrometer. This point, Mr. Scott himself again admits, and takes advantage of by dipping his tool in a solution of sodium chloride.

Sheffield, Eng. W. H. D.

New Method for Base Line Drawings

I was very much interested in Mr. Goldberg's article at page 160, on this subject. Being a draftsman and designer of several years' experience, I am always on the lookout for anything tha. is going to be a help in my work. Here in Connecticut this "base-line dimensioning" is not new, although it has not been carried to the extent described in the article.

When in high school I was taught to put my dimensions on the outside of the piece wherever possible and I agree with Mr. Goldberg on this point. I think that it should not be overlooked but insisted upon where practicable.

I believe that Mr. Goldberg has made an error in having his perpendicular base line go through the center of the 0.140-inch radius (see Fig. 2, page 161). The horizontal line is all right because it comes on a square edge of the work as well as the center of the hole, but the other base line should come, I believe, on the square edge 0.9175 inch from the center of the radius.

I fear that any toolmaker or machinist would use a good many cuss words be-

fore the job was finished if he had to work from such a point. In the first place if he had to work from this point he would have to make a special plug, as 0.280 inch is not a standard size. But before making the plug, stop and think if you could make a plug suitable to work from which could be used on metal 0.072 inch thick.

There are plenty of tools to work with where we can use a straight side or rather two sides at right angles to each other and work from them altogether. It is all right for the draftsman to work from the center of a hole or a radius, but it is different in the shop.

As for dimensioning holes, the method that appeals to me is to mark the hole thus: ¼-inch drill, ¼-inch ream, ¼-inch 20 T. P I.; everyone knows at a glance what is required.

In regard to a radius, if it is a radius that can be drilled, or reamed, always give the diameter; but if it is not a standard size of drill, give the radius, as 0.123-inch R. If it is a fillet, give the radius.

Referring to Mr. Goldberg's Fig. 5, how odd it seems to say that a screw that is 0.094 inch diameter 56 T. P.I. is 0.047 inch times 56. The man making that screw in a lathe will caliper from outside to outside and not from the center out. I do not believe that any better system for screws can be found than to give the diameter or number of the screw and the number of threads per inch.

Another case is a gear. All dimensions should be given from the outside of the gear to the outside, as 40 teeth, 10 pitch, 4-inch pitch diameter, 4.20-inch outside diameter, and so on. Also the dimension lines for the gear should be projected from the side elevation and not across the gear at any angle that may be easiest.

The tailless-arrow scheme is not a good one from my point of view. The pay of the average detailer is not so large that the extra time spent in putting dimension lines on a drawing will cost as much as the mistakes made in the shop by not having them there. As for making the drawing confusing, if the outline is made quite heavy, the dotted lines lighter and the dimension lines very fine, the whole thing black, not allowing any dimension line to touch the piece itself by 1/16 inch, no trouble will be encountered. In some cases it may be best to make the piece twice or four times actual size to show everything plainly if the piece is very small.

In conclusion, a great deal of time must be spent in thinking about a drawing-room system before action is taken. Many things must be considered. First, the man in the shop who has to work from your drawings is human like yourself; second, remember that perhaps you know or understand a little more about drawings than the other fellow and a little extra time spent in making them plain will be doubly repaid; third, put all the information that is necessary to complete the work on the drawings so that the man in the shop will not have to be running back and forth to know what this is and that is. And fourth, and by far the most important of all, stop and think how you would start to lay out the piece if you were at the bench yourself and then proceed to dimension.

I believe that drawings should have two base lines to work from as far as possible, but let them always come on two straight surfaces at 90 degrees from each other and not through the center of a hole or radius.

Bristol, Conn. WALTER J. OLDROYD.

Fairness in Buying Machine Tools

Your very able editorial on page 229, touching on the peculiar propensity which some buyers of machine tools display toward the seller if anything goes wrong with a new machine, has no doubt struck a very weak point in a weak system.

It has become the standard practice with the majority of maufacturers to sell their output on trial of thirty and sometimes even of sixty or ninety days. This despite the fact that their machines are well known to the trade, and that the buyer has no intention of returning the tool he buys, because the guarantee which accompanies each machine safeguards him in every respect.

If a machine is sold f.o.b. factory, the maker is at the mercy of circumstances and unfairness on the part of the buyer, until the thirty or sixty days of trial have elapsed. On arrival a part may have been broken through careless handling on the part of the railroad or the buyer's truckman. Correspondence follows and rather than dispute the matter, the seller gives the customer the benefit of the doubt and makes another part, which is sent and arrives in due time.

Should the machine be heavy and the nature of its construction demand that certain parts be shipped separately, it frequently happens that such parts are assembled in a careless manner, and further damage is done, so that the maker finally has to send a man at great expense to right things.

The writer has in mind a case where a certain firm took advantage of a week's delay in transit, a thirty days' trial and a week to boot for good measure to notify the makers' agent that a chip had come out of the knife—the machine in question being a heavy shear; and that he expected a new knife before making a final settlement.

There was no doubt in the mind of the agent that the matter was simply a case of playing for time, with the addition of an attempt to secure another, spare knife, inasmuch as the machine was used daily in the meanwhile and the chipping did not interfere in the least with its working and was the fault of an inexperienced operator.

However, the knife was furnished without question, although it had a value of about $75—and the return of the chipped one was not requested, the buyer's motive being justly divined, nor was it volunteered on his part; as the agent very logically assumed that it would be cheaper to let him keep the chipped knife than have him talk about the matter and impair his firm's reputation in the least.

A splendid letter of reference, in company of check in payment in full followed this line of procedure on the local representative's part, but the writer entertains a lurking suspicion that the agent has already promised himself solemnly to recoup the loss on the next set of spare parts which form a peculiarity of this particular type of machines.

Another point of unfairness on the buyer's part, which crops out occasionally is a wilful underrating of capacity required when negotiating with the salesman, and this is especially the case where the purchasing agent has the decision to make and not the shop foreman.

Experienced salesmen know that it is dangerous to sell a machine with the understanding that it will perform a certain class of work when in reality a larger and more expensive machine should have been decided upon. It makes considerable difference whether a machine is worked at its maximum capacity day in and day out, or whether its maximum capacity is called upon as the exception.

The temptation to buy cheap is always very strong with the purchasing agent, and by skilfully playing the quotations of rival firms against each other, it is very easy for him to exact promises from the overanxious salesman, which, while they may only be verbal, nevertheless bind his house morally.

The conservative salesman of another firm, who may have quoted on a machine of correct capacity naturally loses the order and his house undeservedly gets the reputation of being high-priced.

Another mistaken policy on the buyer's part is the practice to use deliveries as a club and place an order conditional upon an impossible time to deliver, after having probably allowed quotations to lie in the files unnecessarily long.

Rushing an order rarely improves the quality of anything and breaks up the routine business of the maker to such an extent that during many periods he will rather return the order than allow it to demoralize his organization, although he may suspect that he will not receive another inquiry from the same source.

FRANK GREINER

Jersey City, N. J.

The Precision Slide Rule

I have read with keen interest the criticisms, both favorable and adverse, of my design for a precision slide rule, shown on page 1034, Volume 32, Part 2, which have appeared in these columns. This arrangement was discussed by C. N. Pickworth on page 418, Volume 33, Part 1; by Eugene Messner on page 559, Volume 33, Part 1, and W. G. Dunkley, on page 129, Volume 33, Part 2.

A good excuse by a poor mechanic for an unfinished job is worthless; but a little explanation as to how that job happened to leave the shop is strictly in order. This design was prepared while I was at school and was one of a number of original articles required in the course. Under editorial persuasion it was given forth in its original raw state in one of the school journals; such a publication being public property, this article was subsequently condensed and published in the AMERICAN MACHINIST, without my knowledge. Had I known that it would get away over to England and the continent in this crude form, it would never had seen the light.

Shortly after this preliminary design, it was decided to omit the vertical lines as Mr. Pickworth has also found to be necessary, and a D scale 40 inches long and 1.2 inches high was laid out. That the diagonals are parts of a curve, was made

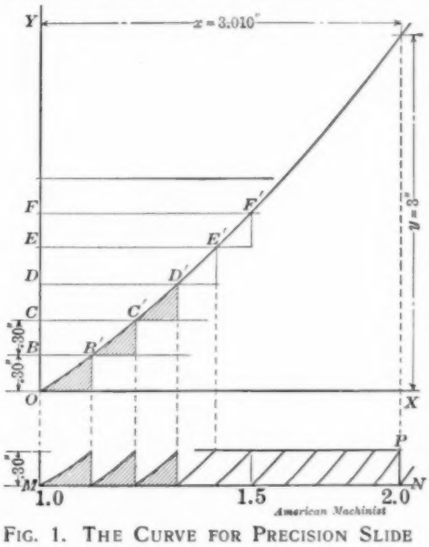


FIG. 1. THE CURVE FOR PRECISION SLIDE RULE

quite evident in the region between 1 and 1.5. This curve was found to be logarithmic, and its general formula to be:

$$x = L \log. \frac{y + h}{h},$$

where

L = Length of scale;
$h = 10 \times$ hight;
y = Total vertical hight of all the diagonals and parts of a diagonal to the left of any given point;
x = Distance of the point from line 1.

This gives the logarithmic principle referred to by Mr. Messner.

The left end of such a curve is shown in the upper portion of Fig. 1. This is for a D scale 10 inches long and 0.3 inch high; here $L = 10$; $h = 10 \times 0.3$ and $x = 10 \log. \frac{y + 3}{3}$. The corresponding slide-rule scale is shown below. In the graph all distances y are measured in inches from $O X$, and all distances x from $O Y$.

To show how values of x and y for such a curve are found, let us take for example, the point P at 2, Fig. 1. Here the diagonals to the left, we know will be 10 in number, and hence their total vertical hight will be $10 \times 0.3 = 3$ inches; therefore $y = 3$ inches, and $x = 10 \log. \frac{3 + 3}{3} = 10 \log. 2 = 3.010$ inches. Having found a series of values and plotted this graph, let the vertical distance on $O Y$, starting from O, be divided into equal parts, $O B$, $B C$, $C D$, etc., each to be equal to 0.3 inch, or the hight of the scale. From B, C, D, etc., let parallels to $O X$ be drawn, cutting the curve and passing somewhat beyond, as shown. At each point of intersection B', C', D', etc., perpendiculars may be dropped onto the line immediately below, forming a series of approximate triangles. These triangles may now be dropped onto a common base, $M N$, Fig. 1, parallel to $O X$. Removing the vertical lines, except at the integral divisions 1, 2, etc., and possibly at the halves, and drawing a line to connect the tops of diagonals, we shall have the scale as it should be, strictly correct and simple.

With Mr. Dunkley, I believe that Mr. Messner has anticipated a greater curvature than actually occurs. The interval of greatest curvature lies between 1 and 1.1, or what is the same, between O and B' as shown exaggerated in Fig. 2. The tangent to any curve is expressed by $\frac{dy}{dx}$ Here

$$dx = 10 d \left(\log._{10} \frac{y + 3}{3} \right) = \frac{10k}{y + 3} dy,$$

where k = modulus for logarithms to the base $10 = 0.4343$.

$$\text{Hence } \frac{dy}{dx} = \frac{y + 3}{4.343} = tan.\ \alpha.$$

$$Tan.\ \alpha_{1.0} = \frac{3}{4.343} = 0.6907;\ \alpha_{1.0} = 34^\circ\ 38'.$$

$$Tax.\ \alpha_{1.1} = \frac{3.3}{4.343} = 0.7599;\ \alpha_{1.1} = 37^\circ\ 14'.$$

As will be observed, this change of slope amounts to only 2 degrees 36 minutes. If the straight-line scale had been drawn, as in the original design, the tangent of the angle that this line makes with the horizontal would be

$$\frac{0.3}{10\ (log.\ 1.1 - log.\ 1.0)} = \frac{0.3}{10\ log.\ 1.1} =$$

$$\frac{0.3}{0.4139} = 0.7245;\ \alpha_8 = 35^\circ\ 56'.$$

The greatest *angular* error, then, at the interval of greatest variance, would amount to only 1 degree 18 minutes. In a similar manner it can be shown that at the interval of least variance, namely, in the division between 9.9 and 10, this error is 2 minutes 27 seconds.

It may be of interest to know what the greatest theoretical numerical error would be. This error occurs very close to 1.05 and is shown some-

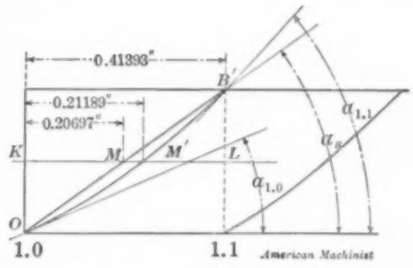


FIG. 2. VARIATION OF CURVATURE, AND ERROR OF STRAIGHT-LINE METHOD

what exaggerated in Fig. 2. The straight line will give a point at M, half way between K and L. $K M = \frac{0.41393}{2} = 0.20697 = 10 \log.\ 1.0488$. Strictly, M should be at M' where $K M' = 10 \log.\ 1.0500$. The error $M M'$ in inches $= 0.00493$, or about three times the thickness of the hair line, and the numerical error $= \frac{10{,}500 - 10{,}488}{10{,}500} = 0.00114$ or a little over 1/10 of 1 per cent. In a similar way it can be shown that the error at the other end of the scale would be 0.0015 per cent.

All the above calculations are based upon a scale 10 inches long and 0.3 inch high. I do not hold that this is, or is not, the best proportion for such a scale; but whatever scale is used the same conditions may be shown to be true, namely; that in the majority of divisions, the departure of the curve from the straight line will not be apparent. Hence no real simplicity is lost in the curved-line design.

This brings up the question, is it not much more difficult to engrave a logarithmic, than a straight-line scale? If an engraving machine is resorted to, where the scale is produced after a master, then the one is no more difficult to divide than the other. If, however, a strictly automatic machine does the work, then it would seem that the logarithmic line would be the better, in that it involves the simpler machine for its production. By inspection of the curves in Fig. 1, it will be evident that any dividing engine whose dividing head moves uniformly back and forth in the direction $O Y$, and whose platen moves simultaneously in logarithmic proportion in the direction $O X$, will trace the desired scale. On the other hand, if the straight-line rule be resorted to, the motion of the dividing head be-

tween each two major divisions must not only be different for each division, but must be *uniform* and *positive* in that interval. Hence to divide a scale as originally proposed would require 90 separate mechanisms for a D scale alone, while any one mechanism which conforms to the law $x = L \log. \frac{y+h}{h}$, would engrave the curved-line scale. Such a mechanism has been designed by myself, but that is "part of another story."

Chicago, Ill. A. N. LURIE.

Rod Storage Rack

A. Harwood, on page 1221, Part 1, Volume 33, describes a rack used for storing bar stock, but does not give a detailed drawing of the castings required.

I was formerly employed as storekeeper in one of the departments of the Pennsylvania Steel Company, Steelton, Penn., where this arrangement was in use and show herewith a drawing of the

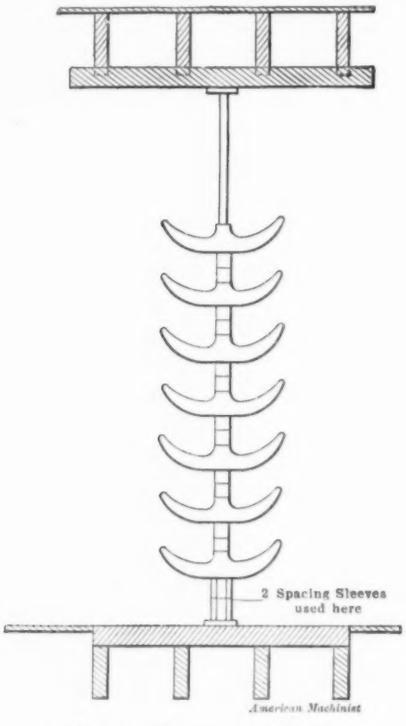


FIG. 1. ROD-STORAGE RACK

rack section and spacing sleeve, as well as the general arrangement.

The assembled rack differs in a few particulars from that shown by Mr. Harwood. Instead of using a large base section for securing the uprights, they are fastened to the floor and ceiling by round floor flanges and lag bolts. The uprights consist of 1¼-inch extra-heavy wrought iron pipe instead of shafting. The pipe is much cheaper and, as it is fastened in two places, is rigid and strong enough for all purposes.

The first shelf section on the rack shown herewith, it will be noticed, is placed several inches from the floor, two or three of the sleeves being used under it. The advantage of this arrangement over the large base section lies in the fact that it is much easier to sweep the floor around the rack. With the base section loaded, it is nearly impossible to sweep around it without unloading it.

The drawing of the shelf casting shows a tapped hole in the boss at one side. This is for the insertion of a set screw to prevent the section from turning on the upright.

Steelton, Penn. STOREKEEPER.

Discussion of the Previous Question—Answering an Ad

John R. Godfrey, on page 196, writes of a machinist who put an ad. in the AMERICAN MACHINIST for a position, reading, "I am a machinist, and I want a job." Mr. Godfrey questions the wisdom of the advertiser in being so brief and in not being more explicit in wording his ad.

Now my opinion is that there are a great many readers of the "Situations Wanted" columns whose attention would be drawn to this ad. through the very fact of its novelty and that the writer would receive consideration for his originality.

There is another point, however, another side of this question which deserves consideration. Many firms spend their good money for ads. in the "Help Wanted" columns, which never bring in a reply. Striving to save a few cents on the cost of space by being brief, they insert a few stereotyped phrases and expect to get results. I refer to those ads. which you run across so often: "Wanted—A draftsman; state age, experience and salary expected." They don't tell us whether they want a structural, mechanical, architectural, or what kind of a draftsman they do want; whether he is expected to work on reinforced concrete work, jigs and fixtures, general machinery, house plans or map work. When there are so many specialized lines of engineering work, it does seem strange that so many firms are so willing to keep pouring out their money for such utterly worthless advertisements.

How many of your readers have answered a "Help Wanted" ad., holding out the prospect of a good position, have hustled to get their letter of application in on the first mail, have sent samples of their work and return postage in case of unfavorable consideration, have waited patiently and hopefully for a reply and have never even been rewarded with a letter of refusal!

Some of the largest firms in the country never write acknowledging receipt of applications except to the lucky party who is picked for the job.

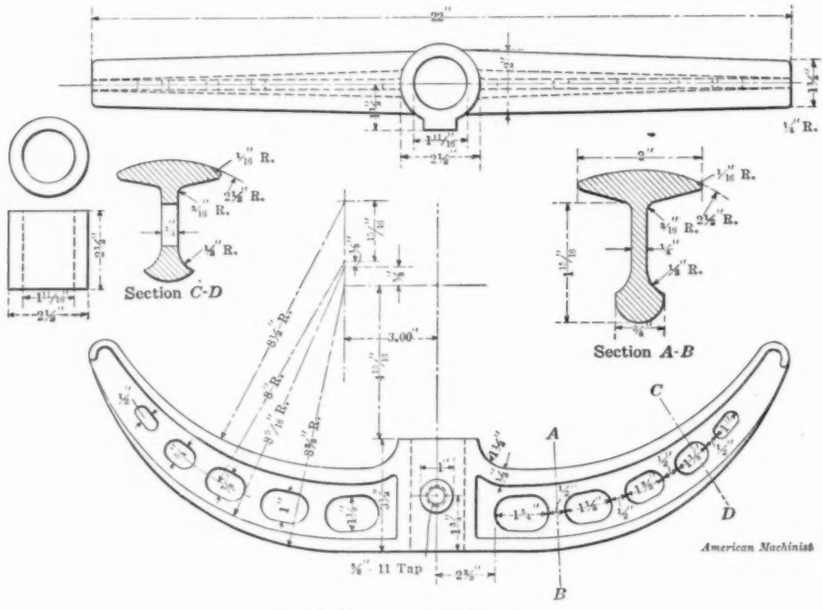


FIG. 2. STOCK-RACK DETAILS

Readers often lose faith in a paper and accuse the advertising manager of "salting" his columns when such cases occur, although the owners of the paper are just as zealous and sincere in preventing them as the readers.

It is time that all firms give the matter some consideration. It is unfair to the readers, the paper in which the ad. appears, and themselves, as tending to destroy confidence.

J. H. HARRIS.

Philadelphia, Penn.

Issued Weekly by the

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American Machinist

Editorial

Progress Toward Good Shop Management

It is gratifying to note the advance that has been made in recent years in shop management. We shall not quibble as to whether we should use the term "scientific management" or "good management" as long as all are working to the same end, that is, the best work for the purpose in the quickest time at the lowest cost, with good wages to those who produce these results.

Today more attention is given this subject than ever before, and the best engineering talent of the country is studying the problem. There seems to be a general awakening to its importance, not only in the payment of increased dividends and the conservation of our resources, both natural and human, but also in its bearing on our struggle for national commercial supremacy.

Many manufacturing plants have increased their output, not by an increase in equipment, but by changes in organization and methods, and an increase in efficiency. In some establishments highly paid experts are employed to make extended investigation of conditions, and to devise the best organization and the best methods. In nearly all cases this has resulted in largely increased efficiency, better wages to workmen, and increased dividends.

It is gratifying to note that the reductions in manufacturing costs have not been made by reductions in wages. In fact it is well established that drive methods seldom, if ever, bring about efficiency, and the methods advocated by experienced organizers provide for largely increased wages to the efficient workmen who put forth their best efforts.

It has also been well demonstrated that management and shop direction must be in the hands of those who have been educated for the work and who have had years of experience in the line. Year by year management becomes more nearly a science. This is almost axiomatic and it would appear needless for us to invite attention to this, were it not that we had to record one important exception to the record of progress of good management.

The naval authorities, in the administration of navy yards, have violated the very elements of good management. Men whose lives have been spent at sea under naval discipline, who had no experience in industrial management and who have little or no knowledge of shop conditions or shop methods, are placed not only in control of the administration of the industrial works, but also in immediate charge of important shops. It seems needless to point out that this must inevitably result in very low efficiency, and a large waste of public money, and may seriously impair our national defense. It is inconceivable that such conditions should exist and we hope that immediate steps will be taken by the naval authorities to remedy these conditions.

Selecting the Right Vocation

Teachers have an excellent opportunity to watch the natural tendencies and capacities of scholars. And though it is not distinctly their province to do so, they can do much toward helping young men in the selection of a suitable vocation. And this is largely the difference between good work and inefficiency.

We have a case in mind where a boy was struggling with mechanics in a night school and making very little progress. The teacher sized up the situation, knew of a good opportunity to learn to be a cook on board a steamer, and the boy took up the suggestion. He made a good cook and is earning better pay than he ever would as a machinist.

If we could weed out the men who are working as machinists but who would make better carpenters, barbers, coachmen or engineers, and be happier doing it, the efficiency of the trade, as a whole, would be increased. But, unless we replenished the supply with misfits in other trades, who ought to have been machinists, our supply of men would run short.

We talk much about the efficiency of the men in a shop as a whole, but this depends on the efficiency of the individual. This in turn depends on whether he is fitted for the work and likes it, or whether he runs a planer because he had to find something and that was the first job that came handy.

We must not expect perfect men. If we did, most of us would be out of a job. But we can come nearer the goal of increasing efficiency by using as much care as possible in helping the boy get started in the line of work that interests him. Although he may not realize it, it takes a big difference in salary to make

up for an uncongenial occupation, and even then there is a lurking feeling of unhappiness that some never get over.

Teachers, parents and employers will do well to try and find out what work interests a boy and to refrain from trying to make him follow certain lines against his will. It is better to be a good chauffeur than a poor lawyer, or to be a really good farmer than a third-rate tool maker. And it is a business proposition to everyone concerned, for when a man likes his work, he does it better and gets more out of life generally.

Making a Definition for Machine Tool

If any of our friends are in need of something to think about, we would suggest that they try their hand at making a definition for "machine tool."

It seems easy until you begin to get something like this:

"An independent mechanism having moving parts which hold and guide a tool and the metal being operated upon."

That sounds like a pretty fair definition until you begin to talk it over with machine-tool men—then you see its weak points at once.

Some object that it does not say "power driven," yet it is difficult to see how a lathe or a shaper is any less a machine tool if you drive it by foot power after the engine shuts down than it was before. The same thing comes up in the use of the word "metal."

If you are turning iron in a lathe it is a machine tool but if you are turning wood, it belongs in another class entirely if the word metal is used.

But, when you come to think it over, is it quite logical to use the word metal at all? Isn't a nicely built buzz planer as much a machine tool as its companion in metal work, the slab milling machine, or a circular saw as its counterpart, the cutting-off or cold saw?

But cutting out the wood-working tools entirely, we still have boilermakers' punches, shears, etc., as well as tinsmiths' shears and other tools which cannot be cut out by any definition we know of. They can be ruled out as undesirable citizens, but it should be possible to make a definition that will fit the case. If we cannot, it seems logical to assume that machine tool is a term having a wider scope than we have been in the habit of assuming.

It would be difficult to rule out a very nicely made punch press for intricate work, and yet the same definition must include the roughest boilermakers' punch. Nor can we logically exclude all boilermaking or sheet-metal working tools, as a plate planer is too closely related to a traveling-head planer for machine-shop use to be disowned in this way.

Altogether it is a question that will bear much careful study and afford useful occupation for considerable spare time.

The Right Basis for an Industrial School

Many cities are considering the establishment of industrial or trade schools and it is obviously impossible that no mistakes be made or money be wasted during the preliminary stages. But we believe that some at least, can be avoided if the organizers will but consider the experience of Rochester, New York, as set forth by George M. Forbes, the president of the board of education of that city.

Their school is known as the Factory School and is based on the plan of a shop with a school attached, rather than the reverse as is usually the case. To quote Mr. Forbes:

The very foundation of an industrial school is in its product in the commercial sense. In other words, if this school was to be a factory school, an industrial school, it must have its foundation laid where the factory lays its foundation. Absolutely everything that pertains to a real factory is built on product or grows out of and depends on the product. And we realized that the only product that had reality was the one that had been placed upon a commercial basis.

In accepting this idea we undertook to make the greatest break from school traditions that was possible, every product of the common school having no reality. The course of study is dictated by the results sought. The product requires estimates and measurements and calculations to make things come out right. By placing the right emphasis on these, mathematics finds its way into the course, and grows out of the needs of the shop.

Fifty boys, under practical men who had been foremen and knew nothing of teaching from the school point of view, produced over two thousand dollars' worth of wood work for the schools of the city as well as electrical work such as bell systems, repairing gongs and batteries, running light circuits and similar work to the value of $135. About half of this was done under the direction of boy foremen.

Another point to be remembered is that a school of this kind can and does start many boys on the right road who would otherwise be drifters all their lives. Every manufacturer knows the various kinds of deviltry that a lively boy of 14 can perpetrate in a shop. Many of them detest the common schools and make themselves obnoxious to everyone in the class. Others are dull at study. Yet in most cases both kinds can be interested in doing some real work if they are handled in the right way, as all industrial teachers can testify. Every boy that can be started right not only adds one to the useful members of society but subtracts one from the other side as well.

We firmly believe that a boy who has the opportunity of learning how to make real, useful products, learning how to make them right, will be happier himself as well as becoming of real value sooner than those who play at shop work. The trade school which is to survive must make the work the first consideration and the "schooling" as a tool which will help in the work, not as a feature by itself.

Obituary

John M. Larmour, manager of the small-tool department of the Baird Machinery Company, Pittsburg, Penn., died on August 17.

Personals*

Charles H. Logue has resigned from the editorial staff of this paper.

W. S. Davenport, president of the Davenport Machine Company, New Bedford, Mass., sailed for home on September 3, after an extended business tour in Europe.

J. F. Buckley, formerly general superintendent of the St. Marys Machine Company, St. Marys, O., has become general manager of the Buckley Specialty Company, Lima, O.

A. S. E. Ackermann, secretary of the Society of Engineers, Westminster, London, Eng., is spending a few weeks in this country prosecuting some work in connection with his consulting practice.

Alfred J. Hill, for a number of years connected with the mechanical-manufacturing department of the Anaconda Copper Mining Company, has resigned his position as superintendent to take up residence in California.

D. E. Williams and J. N. Hannum, engineers, have organized under the firm name of Williams & Hannum, to engage in a general structural-engineering business with headquarters in the Scofield building, Cleveland, O.

L. R. Shallenberger, who was formerly superintendent of construction for the Griffin Wheel Company, Chicago, Ill., has established an independent engineering practice in Paonia, Colo., making a specialty of reservoir and irrigation work.

Albert W. Jacobi, formerly instructor in the Newark Technical School, and for a number of years engaged in various positions with manufacturing concerns in the mechanical field, has established a consulting engineer's office in Newark, N. J.

*Items for this column are solicited.

New Tools and Shop Appliances

Piston Ring Grinder

The halftone illustrates the improved piston-ring and surface grinder, built by the Bay State Grinder Company, Worcester, Mass.

This machine has been designed with ample weight and stiffness to adapt it to any work within its capacity, and to meet the most exacting requirements with gas engine piston-ring fitting.

As illustrated, the Walker magnetic chuck is attached to a vertical spindle, which in turn is driven by spiral gears from the cone shaft, the spiral gears running in an oil bath. The chuck is elevated by a graduated hand wheel. The head which carries the grinding wheel is adjustable so that work may be ground convex or concave, if desired. The advantage of such an adjustment for grinding saws and cutters, can readily be seen. This head is provided with three speeds giving the necessary feeds for roughing and finishing. The spindles and shafts are ground and are provided with adjustable bushings thoroughly protected from dust. The machine is also furnished with hand feed.

A special crank feed which is particularly serviceable for piston ring work can be provided, thus rendering the machine especially efficient in this line for automobile manufacturers.

One of the special features for rapid production, is the pedal clutch-operating device, which enables the operator to start and stop the rotation of the chuck with his foot, thus giving him the free use of his hands for feeding the work to the machine. The same pedal also connects and disconnects the circuit which supplies the current for the chuck; this can also be operated by hand if desired.

The machine is arranged for either wet or dry grinding, and it can be equipped with vertical spindle and cup wheel, if desired. A valve-face grinding attachment with draw-in chuck and an attachment for grinding single cams can also be furnished. No countershaft is needed, as the grinder is driven from the main line.

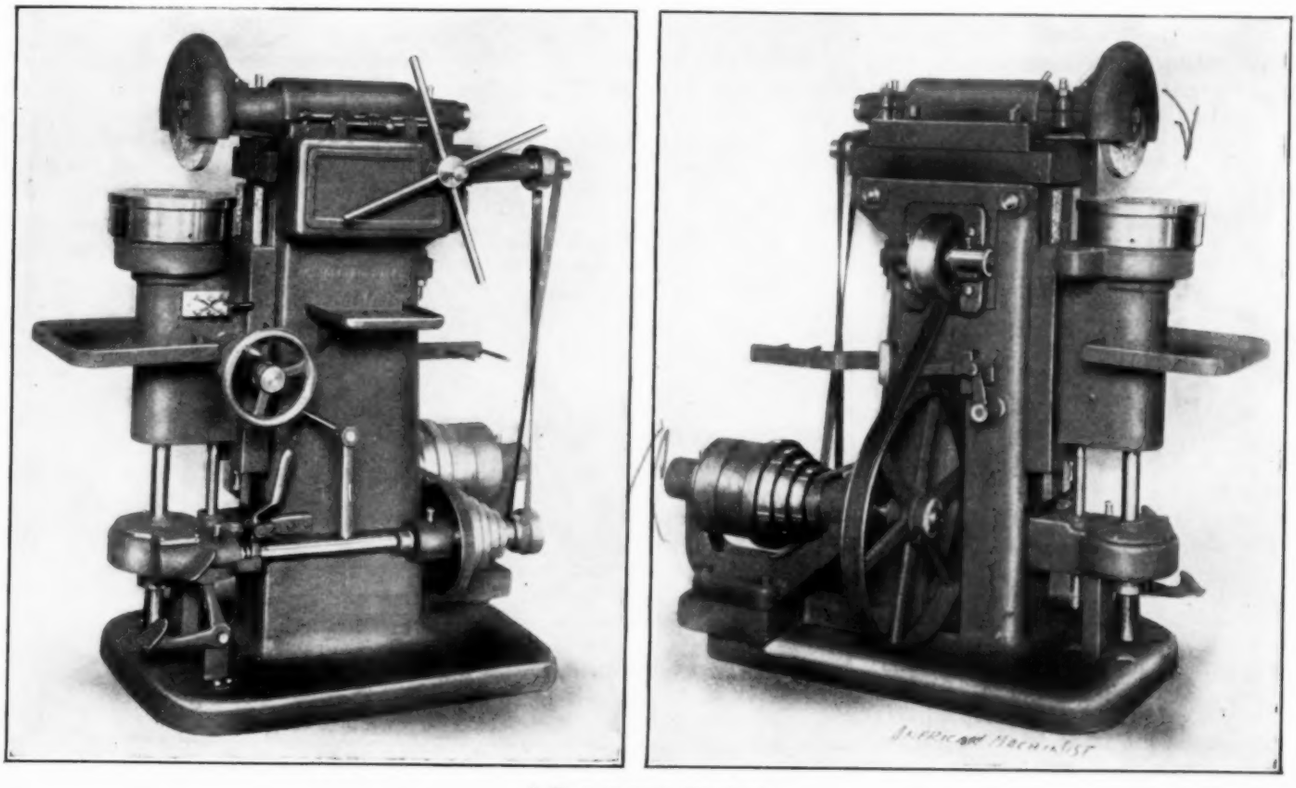
ANY and all new or improved machines, tools, or shop appliances of interest to men responsible for results in machinery-making plants will be briefly illustrated and described here—the machine shop news.

A more full and detailed description will be given—when it is real news—if it can appear here first—before it is sent to other papers. All descriptions appear in ALL four editions of the paper—Weekly, Monthly, Weekly English and Weekly German.

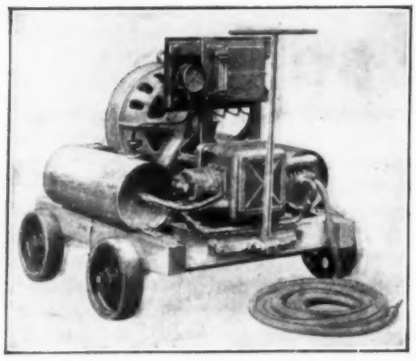
A Portable Electric Driven Air Compressor

The accompanying illustration shows a small portable air-compressor equipment recently built by the British Westinghouse Electric and Manufacturing Company, Ltd., Manchester.

It consists of a standard Westinghouse air-brake compressor, driven through single reduction gearing by a 3-horsepower three-phase Westinghouse squirrel-



A Piston-ring Grinder



A PORTABLE ELECTRIC-DRIVEN AIR COMPRESSOR

cage motor complete, with control panel mounted on a strongly built wooden trolley with rubber wheels, so that it can be easily moved from point to point. The current for operating it is taken from plug boxes on the walls by means of a flexible cable. The connections are so arranged that when the motor is thrown on the line at starting, the fuses are cut out, and after the motor has attained a fair speed, the switch is thrown over to the other side, putting the fuses in circuit.

A Set of High-speed Tap Wrenches

The halftone shows a set of tap wrenches manufactured by the J. E. Poorman Company, Inc., 1825 Bristol street, Philadelphia, Penn.

This wrench is used in the usual way, the nurled extension on top of the handle steadying it in the hand. When the hole is tapped to the proper depth a half turn back, with the cross handle in the hand, will break the chip in the hole, after which the tap is backed out at high speed, with the thumb and forefinger on the nurled extension. The wrenches are made with three sizes of chucks, the jaws of which are broached square on the inside, giving a firm grip on the tap. The chucks take taps from 1/16 to 3/16; 1/8 to 1/4 and 3/16 to 7/16 inch, respectively. The handles are made in three lengths approximately, 3, 6 and 12 inches, respectively.

The New Haven Manufacturing Company's Quick Change Gear

Fig. 1 shows the headstock and part of the bed of a 36-inch triple-geared New Haven engine lathe with complete quick change device attached. With this device 32 different threads and 32 gradations of feed are obtainable by the manipulation of two levers, one of which is shown projecting from the diagonal slot in the gear box, and the other to the left of it.

Fig. 2 shows the rear view of the device. Four variations are obtainable through the nest of sliding clutch gears to the right, while each gear in the cone to the left affords, in combination with the clutch gears, four more variations.

Fig. 3 shows a change feed box giving three changes. This device is furnished instead of the complete quick-change box when so specified. The three-change box is operated by a single lever and with it changes can be made while the lathe is

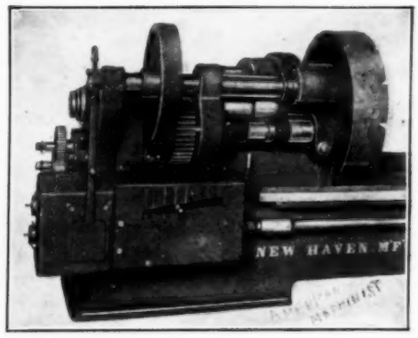


FIG. 1. COMPLETE QUICK CHANGE GEAR BOX; FRONT VIEW

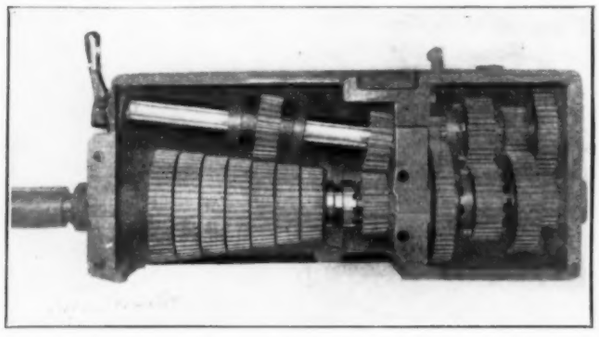


FIG. 2. COMPLETE QUICK CHANGE FEED BOX FOR 32,- 36- AND 42-INCH LATHES

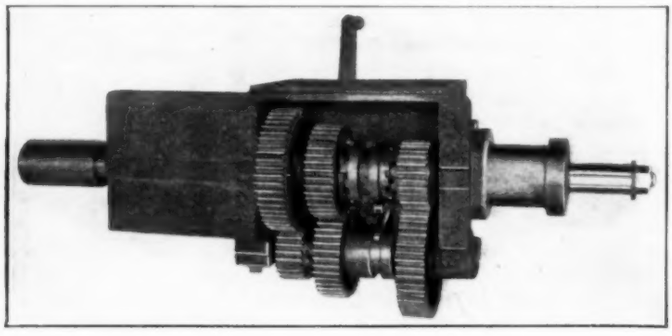
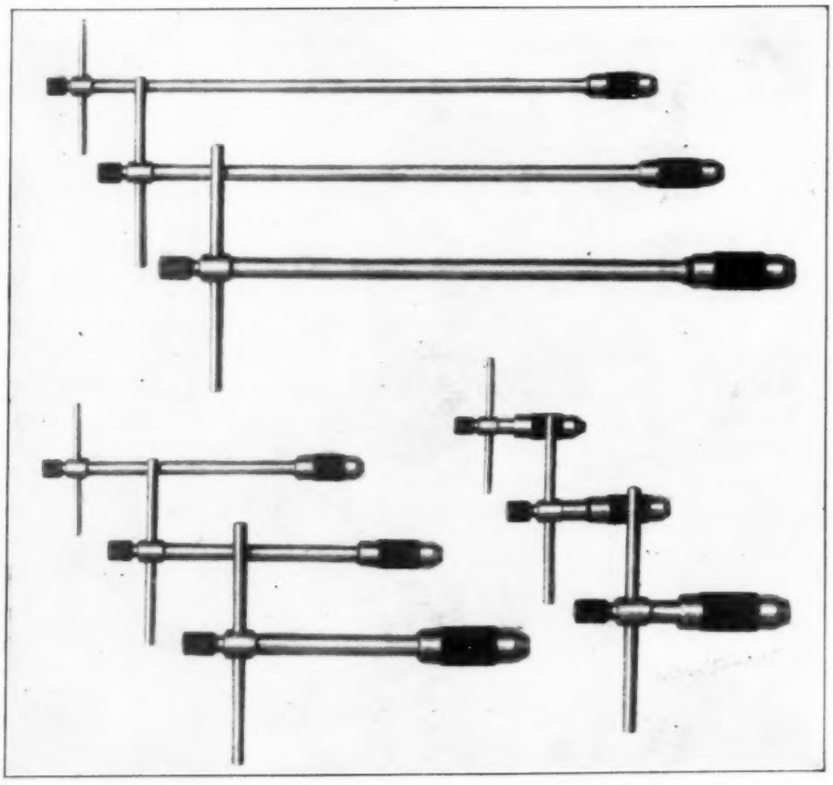


FIG. 3. CHANGE FEED BOX



A SET OF HIGH-SPEED TAP WRENCHES

running without danger of breakage. With either of these devices, threads and feeds not shown on the index plate can be obtained by substituting change gears in the usual way. These quick-change boxes are applied to lathes of their manufacture by the New Haven Manufacturing Company, New Haven, Conn.

A Safety Trip for a Punch Press

Figs. 1 and 2 show a safety lever for punch presses, shifting belts, clutches or similar work.

In Fig. 1 the lever is in the safety position. To start a machine the slide *A* to which is attached the pedal *C*, is pushed forward, releasing it from the

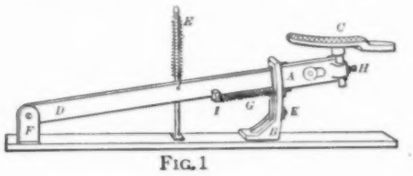


FIG. 1

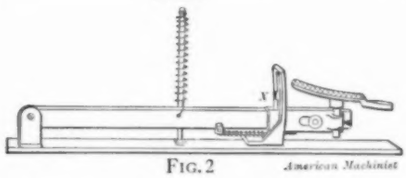


FIG. 2 *American Machinist*

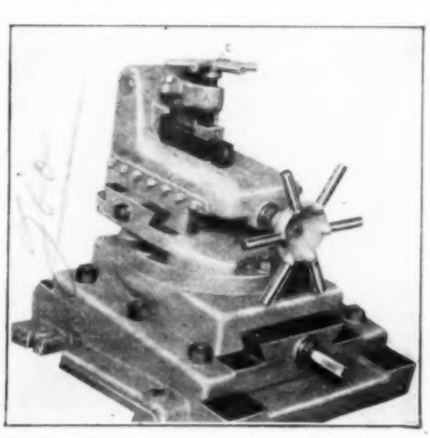
GARDINER'S AUTOMATIC SAFETY LEVER

locking device *B*; the lever *D* can then be pushed downward. When the foot is removed from the pedal the lever is brought back by the spring *E* and the slide *A* is pushed into the safety position by the spring *G*.

Fig. 2 shows the lever in down position and showing the lock *X* clearly. In some factories the foot lever has been done away with to some extent and hand levers are used; the device is applicable to this method of starting and stopping also. It is manufactured by the Crescent Machine Company, Ltd., 15 Dalhousie street, Montreal, Canda.

A Tool Block for Driving Wheel Lathes

The halftones show a tool block for driving-wheel lathes ,built by the Putnam Machine Company, Fitchburg, Mass. The clamp for the tool is novel. The lever *A* has a cam-like projection formed on one end of it, at *B*. In the other end is the clamping screw *C*, which impinges on a hardened block *D* on the top of the tool *E*. The block *D* is removable, but is chained to the tool post to prevent it being lost. In practice the tool *E* is put in place under the lever *A*, the block *D* is then placed on top of the tool under the end of the clamping screw *C*, and the screw tightened, this rocks the lever *A* on its pivot and clamps the tool at the front under the cam *B* and at the back under the screw *C*.



A TOOL BLOCK FOR DRIVING-WHEEL LATHES

A Die Grinder

Figs. 1 and 2 show a new grinder which is being put on the market by F. L. Schmidt, Twenty-first street and Eleventh avenue, New York. The table of the machine shown is a special one used in envelop factories for grinding envelop dies, but a regula rtable with lever or screw feed can be supplied. The table shown is 18 inches diameter with the support eccentric so that the dies can be fastened to the table and the table swung under the wheel. Three inches of vertical adjustment is provided by means of the hand wheel and a fine-pitched elevating screw. The table can be locked in any position by means of

FIG. 1

FIG. 2

A DIE GRINDER

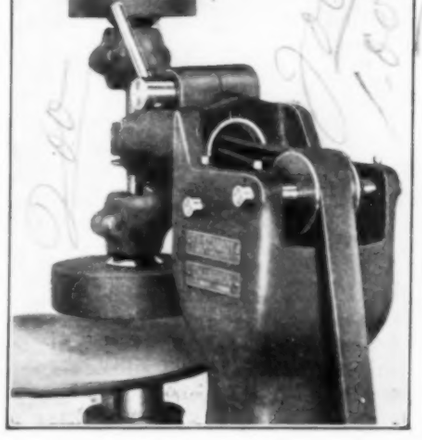


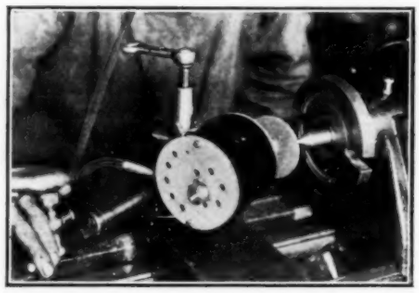
FIG. 3. THE IDLERS

the clamping screw shown. The cup wheels, eight and six inches diameter respectively, have a 7/8-inch hole and are mounted on each end of the spindle, which is 1¼ inches in diameter in the bearings. The spindle can be swung from the horizontal position, shown in Fig. 1, to the vertical position, shown in Fig. 2, while the machine is in motion, and can be changed in any position between these two limits by the binding screw on the top of the column.

Fig. 3 shows the belt drive from the countershaft at the back over the two-flanged idler pulleys. These pulleys are free to slide on their stationary shafts and are adjusting to correct position when the spindle is swiveled.

A Combined Bench and Tool Post Grinder

The halftone shows a handy little tool-post grinder built by the New York Electric Tool Company, 136 Liberty street, New York. It carries a 3-inch wheel ¼-inch face which runs at 6000 revolutions per minute. The spindle runs in tapered, split, phosphor-bronze bushings adjustable for wear. The machine is also provided with a rectangular base, not shown in the halftone, to which it is readily attached, converting it into a small bench grinder. Without the base the machine weighs 8 pounds.



A Combined Bench and Tool Post Grinder

Instruments for Measuring Time

By Henry Abbott *

A brief extract from a very complete historical sketch.

Shows who made the early clocks and watches, and when.

Introducing Yankee clocks into England.

*President, The Calculagraph Company, New York City.

The first machine for measuring time of which we have knowledge was called the clepsydra. The word is of the Greek origin and signifies "water thief." It was, in fact, a water clock.

The time was noted by the descent and ascent of a float on the water in a vessel into which or out of which the water slowly dripped. Sometimes a graduated rod was attached to the float and was raised and lowered with it, the graduations being observed as they appeared above the edge of the vessel.

Long before sun dials were invented clepsydra had been made and used in Chaldea, India and China. Plato introduced them into Greece, Julius Cæsar mentions having found clepsydra in Britain when he visited that country with his army. They had been known in Rome more than a hundred years prior to that time, where they were brought by Scipio Nasica.

The Sun Dial

Anaximander, a Greek astronomer, who was born in 610 B. C. and died in 547 B. C. is credited with the invention of the sun dial. Before his time the Greeks only marked the divisions of the day by the different lenths of the sun's shadow. Recent discoverics, however, prove that the Chaldeans used this instrument several centuries earlier.

It has been supposed that many of the numerous obelisks found in Egypt were erected in honor of the sun and were employed as gnomons, the hour of the day being determined by the length of the shadow instead of by its angular position.

The Sand Glass or Hour Glass

The sand glass was known and used at the very same early time as the clepsydra and operated upon the same principle, the sand taking the place of water and the dropping of a definite quantity of sand through a small opening from one compartment of a vessel to another.

The sand glass was less accurate than the clepsydra and required more constant attention to reverse its position at the proper moment.

Clocks' Early History

The inventor and constructor of the first clock having gear wheels and pinions and driven by weights is not definitely known, nor can the date be fixed with any degree of certainty.

Gerbert, who was Pope under the name of Sylvester II, made a clock at Magdeberg, about the year 996 A. D. In 1232 the Sultan of Egypt sent a "horologium" to the Emperor Frederick II. It is described as being "impelled by weights and wheels so that it pointed out the hour of the day and night with certainty."

Several writers of the eleventh century speak in familiar terms of clocks then in use, but Dante, who lived between the years 1265 and 1321 was the first to mention an horologia that struck the hours.

In 1370 Henry Vick, who was brought from Germany for the purpose, by Charles V, king of France, made a clock at Paris and set it up in the tower of the palace. Although this is the earliest specimen of clock of which a good description has been preserved, it is quite certain that clocks were known and in use in limited numbers in Germany prior to the time that Vick was sent for by Charles V. The art of horology was probably being slowly developed in Germany for more than a hundred years prior to the time of Vick, though our information of it is very meager.

Among early clocks of which we find mention, it is recorded that in 1523 a clock was built for St. Mary's, at Oxford, which was paid for out of fines imposed upon the students of the university.

The Pendulum

In 1583 Galileo, while watching the vibrations of the great bronze lamp swinging from the roof of the cathedral at Pisa, observed that, whatever the range of its oscillations, they were invariably executed in equal times. The experimental verification of this fact led him to the important discovery of the isochronism of the pendulum.

Seventeen years after the death of Galileo, or in 1656, Christian Huygens, who was born at the Hague but who was then residing in Paris, constructed for use in his astronomical researches, a clock to which he applied the pendulum discovered by Galileo. His experience of the need of an exact measure of time in observing and calculating the positions of the heavenly bodies, undoubtedly stimulated his activity in the horological art and led to other important improvements in clock construction, which shall be mentioned later. On the 16th of June, 1657, Huygens presented the first pendulum clock ever made to the government of his native land.

About the year 1600, a device called "the remontoir" was first introduced into clocks. It consisted of a mechanism which would either wind up a small weight or bend up a delicate spring, which, being released, should alone give its force to the escapement by which means the vibrating bar or the balance wheel was supposed to be always impelled by an equal or uniform force.

Watches

Watches, or "pocket clocks," as they were then called, were made many years before the application of the pendulum to clocks; they were certainly in use in the year 1600. Several writers fix the date as early as 1530. These watches had the verge escapement, same as used in Vick's clock, but a balance wheel was substituted for the virbating arm or cross used by Vick, and the motive power was a coiled spring in place of the weight.

These early watches were made entirely of iron, were from four to six inches in diameter, and since the crown wheel rotated vertically to the plane of the other wheels of the train, the frame required considerable depth and the watch was very thick, resembling in shape a very fat onion or turnip.

Watch crystals were first made in 1615, the minute hand and gearing to drive it in 1687, but the second hand was not used until 1780.

The art of piercing rubies and other hard precious stones was discovered by M. Facio, of Geneva, Switzerland, about the year 1700 and soon thereafter he began the manufacture of jewels for watches.

Marine Time Pieces

Philip the Third of Spain, in 1598, offered a reward of 1000 crowns to the inventor of a satisfactory marine timekeeper which could be used to ascertain longitude at sea. The states of Holland soon after offered 100,000 florins; the British Parliament in 1714, during the reign of Queen Anne, voted 20,000 pounds sterling for the same purpose; and the Duke of Orleans, Regent of France, in 1716, promised in the name of the king 100,000 livres.

John Harrison, an Englishman, applied himself vigorously to this task and after several years of experimenting, in 1735 he took to the Board of Longitude at London a timepiece which was tested on board a king's ship in a trip to Lisbon. The result of the test was so satisfactory that the commissioners gave him 500 pounds to carry out further improvements.

Harrison worked on the problem with the utmost perseverance, and after making several models completed one in 1761 which he considered perfect. His son was sent on a voyage with it to Jamaica for the test; and on his return to Portsmouth in 1762 the timepiece was found to have lost only 1 minute 54½ seconds. This was surprisingly accurate for that period, as it determined the longitude within 18 miles, and the specifications required that it should be accurate only within 30 miles.

Escapements

An escapement for clocks made by Doctor Hooke, in which the pallets took the form of an anchor, was fitted with a pendulum and submitted to the Royal Society in 1666. This device Hooke claimed to have made in February, 1656. This date, if correct, would place Hooke four or five months in advance of Huygens in the production of the first pendulum clock; but since Hooke failed to make public his invention until about ten years after Huygens' clock was known, he has never been credited with that distinction.

A watch containing a rack and pinion verge escapement made by Huygens appeared in 1675. It had a pinion formed upon the spindle of the balance and this pinion engaged with a rack or segment of a wheel on the opposite end of which was formed pallets of the Vick type. These watches were first made without the balance spring and when the spring was later applied to them it was discovered that the balance made two vibrations in the same time that it took to make one vibration without the spring.

The famous "Waterbury" watch, which a few years ago furnished material for the joke papers because it required a very long time to wind, contained the duplex escapement in practically the same form as it was left by its last improver—Tyrers, in 1795.

About 1690 the dead-beat escapement for clocks was invented by Graham. All escapements made prior to this date were subject to more or less recoil upon the train of wheels after each drop of a tooth of the escape wheel upon the pallets. Dead-beat escapements are now quite generally used in regulators and expensive astronomical clocks.

Tompion, a London watchmaker, made in 1696 an escapement for watches in which the balance spindle was a solid cylinder. Many years after, Graham, who had been a pupil of Tompion, improved this escapement by making the cylinder hollow and changing the shape of the scape-wheel teeth to the form of wedges. This cylinder escapement proved very satisfactory in ordinary time-keepers and it is still in use.

In 1763 Mudge suggested the use of a small spring which should be bent up by the moving power of the train and at every vibration of the balance it would be released so as to exert its re-turning or unbending force in maintaining the motion of the balance of a watch.

The rack and pinion escapement of Huygens was improved by l'Abbi Hautefeuille, of Paris, in 1722. This invention of Hautefeuille's was known as the "lever escapement." It was very much used for about one hundred and forty years, particularly by English makers of watches. The writer has examined watches containing this escapement, which were made in England as late as 1875.

About 1760 Thomas Mudge substituted a fork-shaped lever for the rack in Hautefeuille's escapement and mounted a small disk bearing a pin made of ruby, upon the balance staff in place of the pinion. This change made by Mudge proved to be a decided improvement in escapements since it left the balance wheel entirely free and detached during a very large part of its arc of vibration and it was not subject to any of the faults charged against all prior watch escapements.

It was called the "detached lever escapement," and was promptly adopted by the French and Swiss makers of watches, later by the English and was the first escapement used by American watchmakers in 1850. It is today the best watch escapement known, and is used throughout the world in all the better grades of watches.

The Balance Spring or "Hair Spring"

In 1658, Dr. Robert Hooke, of London, first applied a spring to the balance wheel of a watch to regulate its movements. He applied for a patent and also filed a description of his invention with the Royal Society.

In 1674, Huygens, of Paris, claimed the same discovery and a lively controversy arose between these two gentlemen and their partisans over their rival claims.

It now appears, from all the evidence available, that Doctor Hooke was unfairly treated in the matter and that he was entitled to credit for a most important discovery in connection with the art of horology. But, though the balance spring was, after the time of Hooke and Huygens, used to a considerable extent, its properties were not well understood by makers of watches until about a hundred years later.

Balance springs are coiled into a variety of shapes, such as a flat spiral, a cylindrical helix, spherical and the "Breguet." The latter is a flat spiral with its outer coil bent up to a higher plane where it is drawn inward to about one-half the full diameter of the spring and terminates with a single coil concentric with the balance staff. This smaller coil of the spring is secured to the stud, near which it passes between the curb pins of the regulator.

This type of spring was invented by M. M. Breguet, a French watchmaker, about the year 1790. It is quite generally used in the better grades of watches made at the present time, because it expands and contracts, with the vibrations of the balance, equally in all directions and always remains concentric with the balance wheel and staff.

Compensation

In a clock having a steel pendulum rod which beats seconds, every variation of temperature of four degrees will cause the clock to gain or lose one second a day, because of the shortening or lengthening of the steel rod, due to such changes of temperature. Thus, if such a

clock were regulated to run accurately in winter at an average temperature of 40 degrees; in summer, at an average temperature of 80 degrees, it would lose at the rate of 10 seconds a day. If the pendulum rod were brass instead of steel, the error would be about twice as great.

To correct this error, due to changes of temperature, compensating devices came to be employed. All have been based upon the varying degrees of expansion and contraction in different metals. Thus pendulums have been formed of several parallel rods of brass and steel, arranged in pairs alternately on either side of the central pendulum rod; usually two pair of brass and two pair of steel rods are employed. The entire arrangement is such as to resemble in appearance a gridiron, hence these are called "gridiron pendulums."

The effect of a rise in temperature on such a pendulum is to elongate the steel suspension rods and thus lower the weights; while at the same time increasing the length of the brass pillars tends to elevate the weight; such a gridiron pendulum was first made by John Harrison, in 1726.

A pendulum compensated by mercury was constructed by George Graham, in 1715. This pendulum consisted of a steel rod, at the lower end of which was secured a sort of stirrup, in which was placed a jar of mercury. The mercury was sufficiently heavy to take the place of the weight usually employed at the lower end of the pendulum; at the same time it became the compensating material, since when the steel rod is lengthened by a warmer temperature the mercury rises in the jar and carries the center of gravity up with it.

It is said that Graham figured out the correct construction of a gridiron pendulum before making his mercurial pendulum, but believing the latter would be the more effective, neglected to make the former, and thus, 11 years later, Harrison received credit for the invention of the gridiron pendulum. The experience of nearly 200 years has, however, demonstrated the correctness of Graham's estimate, since most of the precision clocks of the present day are provided with mercurial pendulums.

The first pocket watch containing a compensating device was made by F. Berthoud, at Paris, in 1764. It was sold in 1766 to a Mr. Pinchbeck for his Britannic Majesty, King George III.

This device consisted of a straight lamina, composed of thin layers of brass and steel fastened together with rivets; one end of the lamina was secured to a stud on the watch plate; the other end being free to move, would, because of the unequal expansion of the two metals, curve toward the steel side of the lamina when the temperature became warmer, and toward the brass side whom the weather grew colder. In the operation of this compensating device, when there was a rise in temperature which tended to lengthen the balance spring and thus make the watch run slow, the lever carrying curb pins would be moved in the direction to shorten the hair spring an equal amount; and when the weather grew colder, the operation of the lamina and the lever would be reversed; the result being that the active and useful part of the balance spring remained the same length in all temperatures.

The compensation balance made by Harrison in 1761 is exactly the same in principle as the balances used in marine time pieces and in watches of the present day. In balances of modern construction, however, the two metals in the lamina are not riveted together, but are brazed, or the brass is melted directly upon and fused with the steel.

Mainsprings

The early makers of watches were much troubled over the unequal tension of mainsprings in their watches. It will be easily understood that a ribbon of steel, coiled and confined within a barrel, with one end of the spring fastened to the barrel and the other end secured to a hub on the "barrel arbor," or spindle, will exert a much stronger force or pull in turning the barrel when it is fully wound, than when nearly run down.

To cure this defect, the "fusee" was devised and introduced into watches at about the year 1775. The arrangement is such that when the spring is fully wound and the tension is greatest, the chain is wrapped around the smaller diameter of the cone and when the spring is nearly run down and the tension is least, the chain exerts its pull in the groove around the greater diameter of the fusee.

The theory of the fusee-and-chain mechanism urged by its advocates was that the force exerted against the watch train was equal at all times; but so much power was lost by this method of transmission that it was found necessary to employ a much wider and thicker mainspring than would otherwise be required.

Gradually, during the next hundred years, the perfected watch of today came to have a very long, very thin and perfectly tempered ribbon of steel for a mainspring, which is confined in a going barrel capable of making more than twice as many turns as are required to keep the watch running 24 hours; the used portion of the spring being taken from the center, the fully wound and the nearly run-down parts of the spring being never brought into action.

The French, Swiss and German makers of watches quite generally abandoned the fusee and chain early in the last century. The Americans, who began to make watches in the year 1850, never employed the fusee at all; but the English watch manufacturers, with great tenacity of purpose, pinned their faith to the fusee and continued to make fusee watches to the bitter end.

The "bitter end" was the loss of the watch market of the world, which the English people, through their wonderful commercial facilities, once commanded, and in which, up to about 1850, their watches held first place and sold for the highest prices because of the excellent workmanship and skill of the English artisans.

Today one might visit a thousand dealers in the United States and not find in their stocks a single example of a watch "made in England," but plenty from Switzerland, France or Germany.

The Chronograph

The chronograph (time recorder) was invented in the United States in 1848 by Dr. J. Locke and was later improved by Prof. O. M. Mitchell, Joseph Saxton and Sears C. Walker.

This instrument makes accurate and permanent records of the error of an astronomical clock which could be read down to the one-hundredth part of a second.

It consists of a cylinder around which is wrapped a sheet of paper, both being rotated by clock mechanism at a uniform velocity; a recording pen is electrically connected with the pendulum of a sidereal clock and makes tracings on the paper at every swing of the pendulum; another pen is placed close to the first over the cylinder and is electrically operated by a key under the hand of the observer, who, through the transit instrument, watches the passage of the object across each of the several spider wires in the field of view of the telescope; by striking his key the observer is able to make a series of dots on the paper, one for the passage of the object across each of the spider lines.

This instrument, with slight modifications of construction in some cases, is now generally used in all astronomical observatories for taking time from the sun or stars. It is sometimes employed to determine the difference in longitude between two places connected by telegraph lines.

For the perfection of apparatus employed in the present system of time distribution throughout the United States we are indebted to Professor Gardiner, of the Washington Observatory, and to Prof. James Hamblet, of New York, who was for many years (prior to his death in January, 1900) an active member of the American Institute of Electrical Engineers.

American Clocks

Clocks were first made in the United States about the year 1800 by Eli Terry in one of the towns in the State of Con-

necticut. These first clocks were made almost entirely of wood. They had wooden plates, wooden wheels and pinions and wooden dials and hands.

Coming from Connecticut, these early clocks were long looked upon with suspicion by people in the other States. They were classed with the wooden nutmegs, wooden hams and cucumber seeds then reputed to be made by the Yankees of that commonwealth.

The manufacture of wooden clocks begun in this small way by Terry grew to be a flourishing industry within twenty-five years, with a dozen or more factories employing several hundred persons and making many different styles of clocks.

About 1832 the first brass clocks were made in this country and by the use of improved machinery they were shortly thereafter produced so cheaply that they entirely superseded the wooden clocks. In 1842 the first consignment of American clocks was sent to London and two men were sent over there to sell them.

It appears that England collected an import duty on clocks at that time, and to prevent under-valuation on imported articles, the customs officials were permitted to seize on behalf of the government any consignment of goods they believed to be undervalued, paying to the consignee an amount 10 per cent. in excess of such valuation; the goods were then sold by auction or otherwise.

The values placed by the American manufacturers on this first shipment of clocks were so much lower than the cost of any clocks made in England at that time, that they were promptly seized and the shipper realized 10 per cent. more for them than he was willing to sell them for.

The enterprising Yankee was so elated over the transaction that he quickly sent two other large shipments, which were seized in like manner, and it was not until the values placed by the American clocks arrived that the English customs people realized that they were bucking against Yankee enterprise and thrift instead of a customs swindler.

There was also a marked improvement in quality as the years went by and improved methods and machinery came to be employed. Several manufacturers undertook the manufacture of high-grade regulators, astronomical clocks and tower clocks which now compete in quality as well as in price with the best products of any country. And the business begun in a small way by Terry has grown to be an industry of considerable magnitude in which many millions of dollars of capital are invested and many thousands of persons are employed.

The Society of Automobile Engineers

Although this is a comparatively new society, it already has 439 members, which gives some idea of the widespread activity of the automobile industry. All men of good personal standing interested in automobile engineering, either as engineers or those who coöperate with engineers, or are competent to fill subordinate positions in engineering work in the many various fields of automobile engineering are eligible for membership.

Probably the most important work which the society has to do is that of the standardization committee, who now have in hand the following subjects: The specification of heat treatment of automobile material; the indexing and classification of automobile engineering literature; the compilation and publishing of an automobile engineer's handbook or pocket book; seamless steel tubing; sheet metals; lock washers; limits for screws and caps; round-cornered square holes and keyways; brake and clutch forging; practice in plain and anti-friction bearing; wood wheel dimensions and fastenings for solid tires; shackled bolts; carbureters; flanges; outlets; bolt-hole center distances; tap screws; gasolene connection; throttle leaders and hold in them; water connection; gaskets; automobile nomenclature, and frame sections.

As the matter of sheet metal alone involves standard measurements for clutches, disks, brakes, drums, bodies, panels, mufflers, radiators, spenders, hoods, fan blades, hub caps, dashes, steps, running boards and miscellaneous stampings, it will be readily seen that this committee has its hands more than full.

There is certainly ample opportunity for valuable work to be done by such a society and the names of the automobile engineers who are prominently connected with it, leave little doubt that the work will be effectively done.

It is reported that a British chemist in the employ of Vicker's Sons & Maxims works has discovered a new alloy of aluminum to be called duralumin. The alloy is little heavier than pure aluminum and is reported to possess the strength of steel. It is declared that the alloy can be rolled, drawn, stamped, extended or forged at suitable temperatures. It is much less easily corroded than other aluminum alloys, and possesses such valuable properties that the firm thinks there is bound to be a large demand for it, and hopes to work the metal on a commercial scale in the near future.

Increasing Shop Capacities

Metal Working

NEW ENGLAND

The Trumbull Electric Company, Plainville, Conn., has plans for a new three-story factory building.

John N. Eames, 28 Burget avenue, Medford, Mass., is in the market for a small screw-cutting lathe.

Walker & Davison are erecting a factory at Bansfield, near Attleboro, Mass., for the manufacture of pens.

The Page & Baker Manufacturing Company, North Attleboro, Mass., silversmiths, are erecting an addition.

Perkins Electric Repairing Company, 141 Franklin street, Boston, Mass., is in the market for a small engine lathe.

The North & Judd Manufacturing Company, New Britain, Conn., is erecting two factory buildings for the manufacture of harness hardware and buckles.

News items for the sales department—where more equipment will be needed. Authentic news is solicited for this department, not rumors or gossip—facts.

MIDDLE STATES

E. D. Drake, Leington, Ky., will erect a garage.

The Reddin Iron Works, Syracuse, N. Y., will erect a new factory.

Fire destroyed garage of Thomas Kennedy & Sons, Cohoes, N. Y. Loss, $30,000.

B. H. Bias and Alpheus B. Cochrane will erect a $20,000 garage at Cumberland, Md.

The Wiard Plow Company, Batavia, N. Y., will build a foundry addition to its plant.

The Cambria Iron Works, Johnstown, Penn., will rebuild wire mill destroyed in the flood.

The Cleveland (Ohio) Foundry Company is planning the erection of another large plant.

The Superior (Wis.) Iron Works will erect a two-story machine shop at 302 Grand avenue.

The Baltimore & Ohio Southwestern railroad will erect a twenty-stall roundhouse at Flora, Ill.

The J. I. Case Threshing Machine Company, Racine, Wis., will build an addition to its boiler shop.

The Gunn Motor Company, Utica, N. Y., will build a third factory at Bleecker and Oscar streets.

The Cream City Brewing Company, of Milwaukee, Wis., will erect a garage and barn to cost $25,000.

Fire did about $12,000 damage at the plant of the Cadillac (Mich.) Water and Light Company.

The Thomas Brass and Iron Company, Waukegan, Ill., wil lrebuild its plant recently destroyed by fire.

The Addressograph Company, Chicago, Ill., will erect a five-story factory at 901 West Van Buren street.

The Eureka Smoke Consumer Company, of Rochester, N. Y., will erect a factory in Hamilton, Ontario.

The Rotary Engine Company, 53-63 Park Row, New York, is trying to find suitable location for factory.

The Vulcan Furnace Company, of Buffalo, N. Y., will move to Warren, Ohio, where new plant will be erected.

The Wright Aëroplane Company, Dayton, Ohio, has purchased site and has commenced erection of new plant.

Crandall, Stone & Co., Binghamton, N. Y., making carriage hardware, is erecting an addition to machine shop.

Joseph Oschwald, 418-420 Washington street, Newark, N. J., will erect a three-story garage and workshop.

The Buffalo (N. Y.) Tool Supply Company, No. 30 Chapin block, is looking for suitable site on which to erect factory.

Permit has been taken out for a new factory for the International Voting Machine Company, Elgin, Ill., to cost $20,000.

The New York Central & Hudson River railroad is building a new car shop at Oneida, N. Y. Will also erect new machine shop.

The American Automobile Manufacturing Company, with plants in Chicago and Kansas City, is planning to erect a plant in Louisville, Ky.

The Chandler & Price Company, Cleveland, Ohio, will erect a four-story addition which will be a combination foundry building and power plant.

The Woods Motor Vehicle Company, 535 West Fifty-sixth street, New York, is said to be considering the location of its factory in the Central West.

The New York, Ontario & Western railroad has erected new machine shop at Oswego, N. Y., for which entire equipment has not as yet been purchased.

The Rogers-Brown Iron Company, Buffalo, N. Y., plans to erect six one-story buildings at Fletcher and Sophia streets, to be used as a structural steel plant.

The Sabin-Curtis Machine Company, Cleveland, Ohio, succeeding the Sabin Machine Company, will erect a new plant, for which some new equipment will be needed.

The Davis Expansion Boring Tool Company, 3914 North Broadway, St. Louis, Mo., will erect a new plant. It is said about $100,000 will be expended for new tools.

The Standard Auto Sales Co., Youngstown, Ohio, has secured quarters in the K. of C. building, which will be occupied as a sales agency and automobile repair plant.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open bids September 27 for one universal milling machine, as per schedule No. 2888.

The Pennsylvania railroad is having plans prepared for new buildings at Orangeville, Md., including boiler works, machine shop, repair factory and construction departments.

The John T. Jones Holding Company, Camden, N. J., has been organized to manufacture iron, steel, copper, etc. Capital, $1,000,000. Incorporators, J. T. Jones, A. G. Jones, W. Jones.

The Prest-O-Lite Company, of Indianapolis, Ind., has bought site in Seattle, Wash., on which a branch factory will be erected. The company manufactures gas tanks for automobiles.

The American Safe and Vault Company, Mansfield, Ohio, recently incorporated, is seeking a location for plant for the manufacture of safes and vaults. Richard D. Ewing is president.

The Hoyt Electric Company, Indianapolis, Ind., has been incorporated to manufacture electric devices. Capital, $50,000. Incorporators, E. S. Van Camp, E. V. H. Shockney, E. T. Hoyt.

The Hippisley Hook and Eye Company, New York, has been incorporated to manufacture hooks and eyes. Capital, $100,000. Incorporators, L. E. Salmon, C. E. Waldo, T. G. Fischer.

Wonder Worker Shoe Machinery Company, Montclair, N. J., has been formed to manufacture shoe machinery. Capital, $1,000,000. Incorporators, J. C. Moye, R. K. Seveille, H. J. Christensen.

The Crescent Foundry Company has been organized at Rochester, N. Y., to operate foundry. Capital, $10,000. Incorporators, John A. Histed, Michael Froehler, Frank M. Erden and others.

The Kilbourne & Jacobs Manufacturing Company, Columbus, Ohio, is receiving bids for an addition to its plant on North Fourth street. The company manufactures wheelbarrows, plows, trucks, etc.

The old Huron steel and iron plant at Lorain, Ohio, has been purchased by the Crucible Steel Company of America, which will soon be placed in operation. Between 300 and 400 men will be employed.

The Washburn Manufacturing Company, Syracuse, N. Y., has been incorporated to manufacture radiators, valves, etc. Capital, $125,000. incorporators, John L. Washburne, James A. Geddes, C. M. West.

The Harrison Radiator Company has been incorporated at Lockport, N. Y., with $30,000, to manufacture radiators, machinery, etc. Incorporators, W. H. Upson, Byron V. Covert, Oscar A. Larsen, Herbert C. Harrison.

The Dayton Surgical Specialty Company, Dayton, Ohio, has been incorporated to manufacture surgical instruments. Capital, $20,000. Incorporators, Daniel C. Westerfield, Erus C. Harley, C. P. Watson, and others.

The National Steel Recovery and Reduction Company, of Pittsburg, Penn., has been incorporated with $100,000 capital to manufacture steel and other metals. Incorporators, F. Dievener, Arthur B. Clark, Burton A. Trip.

The Walden-Dyott Comuany, New York, incorporated with $40,000 capital to manufacture and deal in automatic devices. Incorporators, Henry W. Walden, 37½ St. Marks Place; George M. Dyott, 50 Church street.

The Youngstown (Ohio) Iron and Steel Roofing Company will erect a three-high plate mill and a jobbing mill at its Haselton plant in connection with the addition to the pressed steel department now being constructed.

The Belmont Motor Vehicle Company, Castleton, N. Y., has been organized to manufacture, sell and repair motors, engines, vehicles, etc. Capital, $25,000. Incorporators, H. H. G. Ingalls, Arthur C. Chevey, C. D. Woodford.

The James H. Roberts Elevator Company, New York, has been incorporated to build and repair elevators and hoisting machinery, etc. Capital, $25,000. Incorporators, James H. Roberts, David H. Roberts, 430 Broadway, and others.

The Monobrake Company, Babylon, N. Y., has been incorporated with $125,000 capital for the purpose of manufacturing and dealing in brakes, equipments and supplies for autos, etc. Incorporators, P. Krause, W. G. Nicoll, D. Sandman.

The Behringer Radiator Works, Ticonderoga, N. Y., has been organized to manufacture and sell sectional automobile radiators, etc. Capital, $100,000. Incorporators, H. Behringer, C. Lynn, New York City; E. Behringer, Brooklyn.

The By-Ring Manufacturing Company, Olean, N. Y., has been organized to manufacture and deal in washboards and metal specialties. Capital, $50,000. Incorporators, J. D. Ringrose, J. E. Byrnes, Rochester; F. S. Sherman, Olean.

The Tyson Company, Canton, Ohio, has been incorporated to manufacture and sell machinery for pasteurizing milk, ice-cream freezers, and dairy appliances. Capital, $75,000. Incorporators, Joseph Biechele, Sr. Joseph Biechele, Jr., Frank Tyson, and others.

The Aërial Manufacturing and Supplies Company, New York, has been incorporated to manufacture aëroplanes, automobiles, hydroplanes, etc. Capital, $50,000. Incorporators, Samuel Shethar, Great Neck, N. Y.; Charles H. Stoll, 55 Liberty street, New York, and others.

American Aëroplane Manufacturing Company, New York, has been incorporated to manufacture aëroplanes, motors, etc. Capital, $100,000. Incorporators, Benjamin E. Freed, 506 East One Hundred and Eighty-eighth street; Stuart J. Lebach, 50 Morningside avenue, and others.

SOUTHERN STATES

The plant of the A. G. Perry Plow Company, Coldwater, Miss., was destroyed by fire.

The Engineer Equipment Company, Wheeling, W. Va., has awarded contract for erection of a garage.

The Dameron Garage Company has been incorporated at Tifton, Ga., by R. L. Dameron, L. Pickard and J. W. McWilliams.

The Andalusia (Ala.) Motor Car Company has recently been incorporated and will conduct a general repair shop. A. P. McGowin is president.

WEST OF THE MISSISSIPPI

The Homestake Mining Company, Lead S. D., is erecting a blacksmith shop.

The Chicago & Northwestern railroad will erect a roundhouse at Kasota, Minn.

The Chicago & Northwestern railroad may enlarge roundhouse at Belle Plaine, Iowa.

Oliver Sprouse and Frank Filbert, of Forbes, N. D., are erecting a blacksmith shop.

The Clear Lake (Iowa) Auto Company will erect a building 22x100 feet for machine shop, etc.

The Waterloo (Iowa) Drop Forge Company will erect a new building at Falls avenue and Orr street.

A factory will be erected on Santee street, Los Angeles, Cal., by the Union Hardware and Metal Company.

The Moon Motor Car Company, Denver, Colo., will erect an addition to have floor space of about six acres.

The plant of the Ottumwa (Iowa) Box Car Loader Company was destroyed by fire. Loss, $100,000. Plant will be rebuilt at once.

Contracts have been let for erection of a machine and blacksmith shop to cost $160,000, at La Grande, Ore., for the Oregon Railroad and Navigation Company.

The Union Pacific railroad is making arrangements for the erection of a new round-

house at Belleville, Kan., to replace the one recently destroyed by windstorm.

The San Diego Electric Railway Company will erect a machine shop 125x200 feet at Fifteenth and L streets, San Diego, Cal. Contract for same will be let at once.

The Brandt Manufacturing Company, Hastings, Mich., having outgrown its present location, is seeking suitable location for a plant for the manufacture of its agricultural sprayers.

The new shops of the Salt Lake railroad at Los Vegas, Cal., are rapidly nearing completion. The shops at Los Angeles will eventually be closed and the men moved to the new location.

The manual arts building of the new Polytechnic school, Pomona, Cal., has recently expended over $2500 for lathes, boring machines, drill presses and small tools. It is expected to add to this equipment by additional purchases as the season progresses.

CANADA

The National Motor Company will locate a factory at Montreal, Canada.

The Wire and Cable Company, Montral, Canada, is extending its plant.

The Canadian Grain Shocker Company will build a factory at Chatham, Ont.

The Canadian Pacific is building large new car shops at Fort William, Ont.

The St. Lawrence Bridge Company will locate a large factory at Montreal.

The McFarlane Ladder Works, of Toronto, Ont., is building a large iron-working shop.

The Sheet Metal Products Company, of Toronto, Ont., will locate a large plant there.

The Canadian Westinghouse Company, of Hamilton, Ont., is building additions to cost $100,000.

The American-Abell Engine and Thresher Company is building additions to its plant in Toronto, Ont.

General Manufacturing

NEW ENGLAND

The Houlton (Me.) Woolen Mill will erect a new mill.

The Seekonk Lace Company, Pawtucket, R. I., will double size of plant.

H. N. Barber, of Phenix, R. I., will start a shoe-lace factory at Black Rock.

The plant of the Woonsocket (R. I.) Comb Company was badly damaged by fire.

Marshall Brothers, Fall River, Mass., hat manufacturers, will erect new factory.

The Windham Silk Company, Willimantic, Conn., will build a four-story factory.

The Brookline (Mass.) waterworks is anticipating the addition of another pump.

Caderas & Ozanne, lace manufacturers, Pawtucket, R. I., will install new equipment.

The Mount Hope Finishing Company, North Dighton, Mass., is erecting an addition.

The Dresden Lace Works, a German concern, will establish a factory at Norwalk, Conn.

Allen P. Wilson, New Boston, N. H., is in the market for a 15- to 20-horsepower oil engine.

The United States Navy will build an oil storage plant at the Bradford, R. I., coaling station.

The axe-handle factory of J. H. Tateen at Eastford, Conn., was destroyed by fire. Loss, $10,000.

Fire destroyed the factory of Brayman Woodenware Company, Phillips, Me. The company manufactured clothespins.

The Beverly Box Company, Beverly, Mass., has incorporated to manufacture boxes. Capital, $17,000. P. R. Eaton, of Fitchburg, Mass., is president.

The Noyes Paper Company, Haverhill, Mass., has been organized to manufacture and deal in paper. Capital, $10,000. James A. Kerrigan, president.

MIDDLE STATES

The Oneonta (N. Y.) Milk Company is erecting a two-story creamery.

Fire destroyed factory No. 4 of the Williamstown (N. J.) Glass Company.

L. P. Rays, Carthage, N. Y., is erecting a factory for manufacturing automobile lampshades.

The plant of the Bagley Pottery Company, Zanesville, Ohio, was destroyed by fire. Loss, $15,000.

Paris, Ill., is to install a filtration plant to cost about $30,000 at the municipal waterworks. Peter Lycan, city engineer.

The Weatherproofing Nail Company, 451 North avenue, Baltimore, Md., is inspecting factory sites with a view of obtaining larger quarters.

The Ohio State Reformatory will install new unit of 75 kilowatt, new boiler-feed pump, new system of heating and remodel ventilation plant.

The city of Mansfield, Ohio, contemplates making additions and changes in waterworks. John Cabell, Director of Public Service, can give full information.

The Kentucky Femaie Orphan School, Midway, Ky., is erecting a three-story building in which heating, lighting and laundry equipment will be installed.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open bids October 11 for one motor-driven blower, as per schedule No. 2886.

The Cuyahoga Rubber Company, Akron, Ohio, has been organized to manufacture rubber articles. Capital, $10,000. Incorporators, W. E. Young, R. L. Kryder, and others.

The Southern Veneer Manufacturing Company, Louisville, Ky., has commenced erection of a new plant at Twenty-first and Standard streets, to replace the one recently burned.

The Fowler Manufacturing Company, Alexandria, Ind., is planning to commence work on new plant in which will be manufactured the Fowler gasoline automobiles and interurban cars.

The Isthmian Canal Commission, Washington, D. C., will receive bids up to 10.30 a.m., September 19, for hose, suction pipe, brake hoes, road machines, etc., as per circular No. 602.

The Kinney-Rowe Company, Chicago, Ill., has been incorporated to manufacture and deal in furniture. Capital, $155,000. Incorporators, Donald T. McPherson, M. B. Wellington, J. D. Dickerson.

The Isthmian Canal Commission, Washington, D. C., will receive bids up to 10.30 a.m., September 20, for suction-dredge ladder, steel castings, electric motors, punches and dies, etc., as per circular No. 603.

S. & J. Tire Company, New York, has been formed to manufacture tires, etc. Capital, $10,000. Incorporators, H. Goldman, 50 East Eighty-sixth street; A. W. Well, 2 West Eighty-ninth street, and others.

The American Tire and Rubber Company, Akron, Ohio, has been formed to manufacture rubber articles, including automobile tires. Capital, $200,000. Incorporators, Frank L. Kryder, Adam Duncan, Gilbert C. Waltz, and others.

The Standard Tire and Equipment Company, Cleveland, Ohio, has been incorporated to manufacture and sell automobiles and to make tops, etc. Capital, $10,000. Incorporators, Thomas Swan, J. A. Craig, James T. Martens, and others.

The Isthmian Canal Commission, Washington, D. C., will receive bids up to 10.30 a.m., September 30, for castings, cold-rolled steel, wire rope, steel and brass tubing, pipe fittings, valves, cocks, oil cups, bolts, nuts, twist drills, rail benders, jacks, grindstones, steel tapes, hose, packing, etc., as per circular No. 604.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open bids September 20 for 4800 pounds rounds naval brass, 500 pounds wire-solder (schedule 2876), 1500 pounds round naval bronze (schedule 2866), 3000 pounds bar flat iron, 8000 pounds galvanized medium steel shapes, galvanized sheet steel (schedule 2873).

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open bids September 20 for magnesia pipe covering, fire bricks, steam hose (schedule 2878), 900 dozen hacksaw blades, screw wrenches (schedule 2872), 20 chain blocks, 75 dozen wire-casting brushes, folding platform scales (schedule 2877), 20 pneumatic riveting hammers (schedule 2874).

SOUTHERN STATES

The Danville (Va.) Knitting Mills will build a $10,000 addition .

The State Tuberculosis Sanitarium, Alto, Ga., will erect a power house.

The town council, Fort Mill, S. C., is considering construction of waterworks.

The Hazel-Atlas Glass Company, Wheeling, W. Va., is erecting a four-story addition to its plant.

A. T. Kelley & Co., Gainesville, Fla., manufacturing crates, etc., will soon commence work on new factory.

The Mobile (Ala.) Woodenware Company is looking for location for factory for making crates, baskets, boxes, etc.

WEST OF THE MISSISSIPPI

City of Vernon, Texas, voted bonds for construction of waterworks.

The Greenville (Texas) Railway Company will construct a power house.

The Jamestown (N. D.) Dry Cleaning Company will erect two buildings there.

The Tri-City Button Works, at Davenport, Iowa, will erect a two-story addition.

The Lehigh Cement Company will erect a $3,000,000 plant at Mason City, Iowa.

The city of Britton, Okla., will vote on issuing $35,000 bonds for waterworks.

The Fort Madison (Iowa) Gas Company will increase the capacity of its plant.

The city of Tulsa, Okla., will install another pump of 4,000,000 gallons capacity.

A pumping station will be erected for the city of El Centro, Cal., at a cost of $2200.

The Olympia Brewing Company, of Hoquiam, Wash., will erect a cold-storage plant.

The Maier Brewing Company, Los Angeles, Cal., has completed an addition to its plant.

The Goliad (Texas) Water and Light Company contemplates establishing an ice plant.

The Tulsa Corporation, Tulsa, Okla., will install a 600-kilowatt turbine and additional boilers.

The Wheeler-Reese Lumber Company's sawmill at Lakehead, Wash., was burned. Loss, $85,000.

The sawmill of the North Banks Lumber Company at Yacalt, Wash., was burned. Loss, $10,000.

The Peacock Flour Mill, at Milton, Ore., was destroyed by fire. Loss, $75,000 to $100,000.

The E. J. McNeely & Co.'s sawmill at Tacoma, Wash., was destroyed by fire. Loss, $550,000.

The Purity Ice Cream Company, Watertown, S. D., is planning the erection of a large new factory.

The Monticello (Iowa) Electric Light Company has secured a site for the erection of an electric light plant.

The Franco-American Baking Company is building an addition to factory on Castelar street, Los Angeles, Cal.

Woodworking machinery, shafting, pulleys, etc., will be installed in the Macy street school, Los Angeles, Cal.

J. H. Brown, of Perris, Cal., will open a planing mill, door and sash factory. A building has already been leased.

The plant of the Globe Grain and Milling Company, Los Angeles, Cal., will be entirely remodeled at a cost of $30,000.

The Plant of the Sioux Falls (S. D.) Produce Company was destroyed by fire. Loss, $70,000. Will be rebuilt.

M. C. Connors, William Nuttal and L. C. Lachlin are interested in the erection of a tissue-paper mill at Ashland, Wis.

The New Method Laundry Company, Los Angeles, Cal., is having plans prepared for an engine-room addition to its factory.

The plant of the Union Ice Company at Mentone, Cal., was destroyed by fire on Aug. 28. It will be immediately rebuilt.

The Los Angeles Railway Company have let the contract for their new paint shop on Fifty-fifth street, Los Angeles, Cal.

Contract has been awarded for the erection of a $10,000 powerhouse at the plant of the Davenport (Iowa) Locomotive Works.

A $10,000 addition to the property of the Kerckhoff-Cuzner Lumber Company at San Pedro (Los Angeles), Cal., will be built.

The plant of the Newman Furniture Company, San Francisco, Cal., at Seventeenth and Valencia streets, was burned. Loss, $25,000.

The Arlington Hotel Company, Santa Barbara, Cal., contemplates installing an electric light and power plant in its new hotel at that place.

The Exchange Packing House Company, Colton, Cal., will soon erect a packing house in this city. Bids are now being asked on the structure.

One of the largest cement plants on the Pacific coast will be erected by Bryan & Bradford, of Los Angeles, Cal., about 15 miles from Riverside.

Tuttle & Pike, engineers of Kansas City, Mo., wil ldraw up plans for the erection of a waterworks plant at Gettysburg, S. D. Plant to cost $15,000.

Plans are being prepared for a new building for Youngs' Market Company, Los Angeles, Cal. A complete refrigerating system will be installed.

The Bartlesville (Okla.) Interurban Railway Company will install another 500-horsepower battery of boilers and a direct-connected generating set.

The Arizona, Mexico & Gulf of California Railroad Company is having plans prepared for a new terminal station, docks, warehouses, etc., at Port Lobos, Ariz.

City of Haskell, Okla., will open bids September 22 for waterworks. Two pumps, boilers, fire hydrants, etc., will be needed. E. A. Riley is town clerk.

The Inland Empire Paper Company, W. A. Brazeau, Milwaukee, Wis., secretary and treasurer, will erect a wood pulp paper mill at Trent, Wash., to cost $500,000.

The Stigler Cotton Oil Company has been incorporated at Stigler, Okla., and will build cotton-oil mill. Capital, $40,000. Incorporators, E. E. Holcomb, L. A. Hodges, and others.

Ginning machinery will be in demand in the Imperial Valley (Cal.) section, contracts have been let for the erection of gin-houses at Calexico, Brawley and Holtville, by the Imperial Valley Oil and Cotton Company, El Centro.

A screen manufacturing concern, whose name has not been made public, has inquired of Leonard G. Coope, Chamber of Commerce, San Diego, Cal., for a suitable site for a factory.

The contract has been let for a new building at Santa Ana, Cal., to be occupied by an agency of the Stoddard-Dayton Company. Facilities for handling automobile repair work will be installed.

The Cottage Hospital Association, of Santa Barbara, is having plans prepared for a three-story hospital building at Oak Park, Cal. A modern heating plant, laundry system, etc., will be placed in the structure.

The Western Grain and Sugar Products Company, whose main factory is at Agnew, Cal., has purchased four acres of property adjacent to the lines of the Southern Pacific and Santa Fé railroads at Vernon (Los Angeles), Cal. A factory will be erected at once.

The San Joaquin Valley Power Company has begun the erection of a station on its 10-acre tract on Union avenue, Bakersfield, Cal. The plant will contain eight boilers of 300 horsepower each, two engines and two 2500-kilowatt generators. The equipment of the present sub-station, which is in the city proper, will eventually be moved to this site. The J. G. White Company is in charge of the work.

The San Diego (Cal.) Electric Railway Company will erect new power plant covering a whole city block in Artic, Cal. This will cost about $225,000 and will have a capacity of 35,000 kilowatts. Two vertical engines will be installed in engine room and in boiler room six batteries of eight water-tube oil-burning boilers each. Engine and boiler rooms will be equipped with traveling cranes of 10 -and 60-ton capacity.

CANADA

North Bay, Ont., will install new waterworks.

Edmunston, N. B., will install new waterworks system.

The city of Hull, Que., will extend waterworks system.

W. Marsh, of Victoria, B. C., will locate a sawmill at Duncans, B. C.

The Durham (Ont.) Furniture Company will make additions to plant.

The Balmoral Brick Company will establish a large plant at Winnipeg, Man.

Chippewa, Ont., will make large extensions to its waterworks pumping plant.

Prince Rupert, B. C., is in the market for equipment for electric lighting plant.

North Buxton, Ont., wants figures for new pump house, wheel, boiler, engine, etc.

The Alaska Feather and Down Company, Montreal, Canada, is erecting a large factory.

A company to be known as the Canadian Silk and Cotton Company, will erect a factory at Beaufort, Que.

The Pacific Exploitation Company, of which G. H. Hall, of Nelson, B. C., is president, has been granted permission to equip a plant to develop 25,000 horsepower on the Pend Orielle river, near Waneta, B. C.

FORTHCOMING MEETINGS

International aviation meet, Belmont Park, Long Island, October 22 to 30. Auspices of the Aëro Club of America, 29 West Thirty-ninth street, New York City.

National Society for Promotion of Industrial Education, fourth annual convention, Boston, Mass., November 17, 18 and 19.

American Society of Mechanical Engineers; monthly meeting second Tuesday. Calvin W. Rice, secretary, 29 West Thirty-ninth street, New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's hotel. D. F. S. Clark, secretary, 141 Milk street, Boston, Mass.

Providence Association of Mechanical Engineers. Monthly meeting fourth Tuesday each month. E. C. Bliss, president, 91 Sabine street, Providence, R. I.

New England Foundrymen's Association; regular meeting second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania; monthly meeting third Tuesday. Elmer K. Hiles, secretary, Fulton building, Pittsburg, Penn.

Superintendents' and Foremen's Club of Cleveland; monthly meeting third Saturday. Philip Frankel, secretary, 310 New England building, Cleveland, O.

WANTS

Rate 25 cents per line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care, 505 Pearl street, New York, will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendations or other papers of value should not be inclosed to unknown correspondents. Only bona-fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

MISCELLANEOUS WANTS

Caliper catalog free. E.G.Smith, Columbia, Pa.

We buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

The "Gas Saver" brazing forge; circular. J. L. Lucas & Son, 2 Fox St., Bridgeport, Ct.

Wanted—Work for screw machines and gear cutter. Box 775, AMERICAN MACHINIST.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Special machinery accurately built. Screw machine or turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Light and medium weight machinery and duplicate parts built to order; tools, jigs, etc. MacCordy Mfg. Co., Amsterdam, N. Y.

Will pay 75 cents for copy of AMERICAN MACHINIST, issue of March 26, 1908. J. O. Smith, 325 Waterman St., Providence, R. I.

Patents. C. L. Parker, Patent Attorney, ex-examiner Patent Office, 990 G St., Washington, D. C. Write for Inventor's Handbook.

Special machinery, model and experimental work, tools, punches and dies, drill chucks and universal collets. The Cleveland Collet & Machine Co., Cleveland, Ohio.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMERICAN MACHINIST.

Those breaks on power plant or machinery! Are you going to lose time awaiting new parts from makers, or will you let us weld them at one-fourth to three-eighths cost of replacements? Re-shipment within 24 hours. Oxy-acetylene process, producing homogeneous weld of cast iron. No charge unless successful. Waterbury Welding Works, Waterbury, Conn.

HELP WANTED

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Wanted—Salesmen to handle on a generous commission basis, a well advertised and quick selling line of lathe tools; commissions given on all orders received from prescribed territory; send references with reply. Address "R. T.," AMERICAN MACHINIST.

Wanted—Salesman experienced in machinery or electrical lines to sell new line of portable electric tools on liberal commission basis; will allow definite territory to the man who will really work it; we know what can be done with this line and want a hustler to do it. Box 946, AMERICAN MACHINIST.

Wanted—For England in mills making brass and copper tubes, plates and rods, a competent overseer; a clever millwright with uptodate knowledge of methods of manufacture and capable of applying same, is the person required; state age, qualifications, previous situations and salary required. Care "Roller," P. O. Box 459, Hartford, Conn.

ILLINOIS

Wanted—Experienced general patternmaker; also a machinist acquainted with electrical equipment. Fetzer & Co., Springfield, Ill.

Wanted—An assistant superintendent by growing manufacturer of sheet-metal goods. Town of 10,000; 180 miles from Chicago. Box 938, AMERICAN MACHINIST.

MASSACHUSETTS

Wanted—High-grade designing draftsman with large experience in steam engineering practice for permanent position with a large manufacturing concern in Massachusetts. State age, education, eperience and salary expected by addressing Chief Draftsman, Box 950, AMERICAN MACHINIST.

Wanted—Salesman experienced in machinery or electrical lines to sell new line of portable electric tools on liberal commission basis; will allot definite territory to the man who will really work it. We know what can be done with this line and want a hustler to to do it. Box 945, AMERICAN MACHINIST.

MICHIGAN

Wanted—At once, draftsman with at least two years' experience on gasolene engine and engine jig work; none but first-class man need apply. Box 917, AMERICAN MACHINIST.

NEW YORK

Wanted—Machinist for repairs in large school; about $4 a day; must be graduate of high school and 5 years at trade. Box 944, AMERICAN MACHINIST.

Wanted—An all-around machinist, prefer an elderly man willing to work for moderate wages at light steady work. Give references and full particulars. Box 951, AM. MACH.

Designer, expert on all kinds of punches and dies, capable of planning work and designs for draftsman. State age, experience, nationality, references and salary expected. Box 941, AMERICAN MACHINIST.

Wanted—Steam and board drop hammermen; state experience and where employed last; also a drop-forge foreman; must be A-1 man. Address reply to Superior Motor Vehicle Co., 1449 Niagara street, Buffalo, N. Y.

Firm manufacturing motor vehicles requires a draftsman who has had automobile experience. Address in own handwriting, giving age, nationality, experience in detail and salary expected. Box 937, AMER. MACHINIST.

Draftsmen Wanted—A large and well known automobile company in New York State requires experienced mechanical draftsmen and detailers; give age, experience and salary expected and when could report for work. Box 898, AMERICAN MACHINIST.

A large technical school in Greater New York desires the services of a young man as assistant in the mechanical laboratory; a technical graduate preferred. Entering salary $800 a year. Personality preferred to teaching experience. Box 949, AMER. MACH.

Factory superintendent required; only first-class man with first-class references, thorough experience, used to handling not less than four hundred men in electrical instrument, gun, watch, machine tools, adding, typewriting, sewing-machine making need apply. Faculty of handling men, best modern shop practice, greatest accuracy, combined with quantity, absolutely indispensable. Handsome salary and good future assured by large English company starting works in this country. State fullest particulars, salary, etc. Box 936, AM. MACH.

Machine shop foreman required; only first-class man with first-class references, thorough experience, used to handling not less than one hundred men in electrical instrument, gun, watch, machine tools, adding, typewriting, sewing-machine making need apply. Faculty of handling men, best modern shop practice, greatest accuracy combined with quantity absolutely indispensable. Handsome salary and good future assured by large English company starting works in this country. State fullest particulars, salary, etc. Box 935, AMERICAN MACHINIST.

OHIO

Wanted—Draftsman who has had experience on compressors and Corliss engines; state age and experience. The Heisler Co., St. Marys, O.

Wanted—Draftsman familiar with boiler-room practice, October 15; location northeastern Ohio; state age, qualifications and experience fully. Address Vulcan Furnace Company, Ellicott Square, Buffalo.

Wanted—Superintending foreman of machine shop, northeastern Ohio, October 15. State experience, qualifications fully, specifying age and compensation required. Address Vulcan Furnace Co., Ellicott Sq., Buffalo.

Wanted—First-class machinists, toolmakers die sinkers, lathe, planer, drill press, screw machine, boring and milling machine operators, wood patternmakers, brass molders, polishers, buffers, finishers, spinners, millwrights, hammermen and blacksmiths who are seeking positions or desirous of improving on those which they have, to register their names and addresses with the free Employment Department of the National Metal Trades Association. Address Commissioner's Office, 605 New England Bldg., Cleveland, O.

PENNSYLVANIA

Wanted—Floor hands and fitters on machine tool work. Colburn Machine Tool Co., Franklin, Penn.

Blacksmith foreman for Philadelphia plant; fully experienced and competent to take entire charge of 200 men and thoroughly familiar with heavy forging machines, steam drops, bulldozer., etc. Box 905, AM. MACH.

The Monotype School is maintained to train young men to meet the constant demand for operators of our type casting and composing machine; these operators do so well that we receive more applications for places than can be filled; these qualifications carry most weight: Common sense, automatic machinery experience, printing office experience, type foundry experience. Full particulars will be furnished to inquirers who furnish the same information about themselves, and mention this paper. Lanston Monotype Machine Co., Philadelphia.

WISCONSIN

Wanted—Draftsman, bright young man to take charge of a small drafting room. Address "A. Z.," AMERICAN MACHINIST.

Foreman wanted for monitor department; must be strictly first class in every respect, none other need apply; steady work and good pay for the right man. Address Box 934, AMERICAN MACHINIST.

Wanted—A thoroughly capable and experienced machine designer and draftsman; one who has had experience in the building of automatic machinery; give experience, references and salary desired in first letter; if not thoroughly competent do not apply. National Wrapping Machine Company, Enterprise Bldg., Milwaukee, Wis.

FOREIGN

The Commonwealth Government, Commonwealth Offices, 72 Victoria street, London S. W., invite applications for a manager of small arms factory, Lithgow, New South Wales, Australia. Age not to exceed 45. Testimonials, statement of service and qualifications for post required. Previous experience of manufacture of small arms essential. Candidates have to undergo medical examination. Salary £750. Applications to be addressed Secretary, Defence Department, Melbourne, Australia, to arrive not later than October 31.

SITUATIONS WANTED

Classification indicates present address of advertiser, nothing else.

ILLINOIS

Wanted—Position as general superintendent; have had a large experience designing and building gas engines. Box 925, AM. MA.

INDIANA

Mechanical engineer, German graduate, wants change; 7 years' experience in gas and steam engines, excavators. Box 952, AM. MA.

MASSACHUSETTS

Man, 34 years old, technical education, brought up through shop and drafting room to head draftsman, then superintendent in small plant manufacturing medium-size machinery, wants position with larger concern as assistant to superintendent or in production department. Box 932, AMERICAN MACHINIST.

NEW JERSEY

Thorough, practical man wants to become partner with some one who has a small machine shop. Hustler. Box 948, AM. MACH.

Man with exceptional practical experience, both in shop and drawing room, A-1 designer, present engaged, would consider change. Box 947, AMERICAN MACHINIST.

NEW YORK

Sales engineer wishes to represent reliable concern, New York preferred. Address "Mechanical Graduate," AMER. MACHINIST.

Mechanical superintendent of a large manufacturing plant, with twenty years' experience in general machine and foundry practice, desires making a change. Box 901, AMERICAN MACHINIST.

Draftsman, mechanic, 28, nine years' experience in high-grade tools, special machinery and experimental work for sewing machines, typewriters and automatic scales, wishes responsible position. Box 943, AM. MACHINIST.

Ambitious young man, 28 years old, desires a change; is experienced in factory detail, cost and production methods and general office work; has executive ability and is a mechanic; expectations not unreasonable. Box 939, AMERICAN MACHINIST.

German (27), speaks and writes perfectly English and Spanish, perfect bookkeeper, good German shorthand, thorough knowledge of the machine branch, at present employed, wants situation as correspondent or similar position. Box 940, AMERICAN MACHINIST.

Designer, graduate engineer, age 33, over 12 years' experience adding machines, typewriters, fine devices, medium and light automatic machinery, especially strong on experimental work and originating of new machinery, will consider change; location immaterial. Box 928, AMERICAN MACHINIST.

Mechanical superintendent, superintendent of maintenance, superintendent of power plant for consulting engineer; assume full charge of power plant, manufacturing machinery, buildings, etc.; capable of taking a load off manager's shoulders; first-class mechanical engineer, experienced, good education, will consider other mechanical, executive or confidential position; willing to travel, but no salesman's position wanted; bonds if needed; be explicit in your reply. Box 933, AM. MA.

OHIO

Time setting and instruction card specialist solicits correspondence; can show remarkable record of increased production at reduced cost. Box 942, AMERICAN MACHINIST.

Screw machine foreman, now having charge of large automatic and hand machine department producing accurate interchangeable work, desires change; expert tool and cam designer, good executive and capable to handle department along the lines of modern cost and expense accounting; in present position seven years; location immaterial. Address "Foreman," Box 924, AMERICAN MACHINIST.

FOR SALE

For Sale—Screw manufacturing business; excellent opportunity and profits; reasonable price; first-class machinery. Box 913, AM. M.

Four thousand dollars will buy a light manufacturing machine shop, brass foundry and plating works, doing a safe, steady, profitable business in this city; established twenty years; health only reason for selling. For full information address Hoyt Investment Company, 4290 Queen Ave., South, Minneapolis, Minn.

For Sale—Three return tubular boilers, manufactured by Riter Bros., Buffalo, N. Y. Drums 72x16 feet 0 inches; each boiler with sixty-six 4-inch tubes; inspected by Travelers Indemnity Company, of Hartford, Conn; 93 lb. steam pressure; boilers in good condition; can be delivered in two to three months, and seen in operation at Buffalo Bolt Company's plant, North Tonawanda, N. Y.

An opportunity to start a machine shop; we offer one of our departments for sale, the one used to establish our business; it is small and profitable work, but as we are devoting ourselves to heavier work, we offer to sell for $2000, all the drawings, patterns, and stock of finished and partly finished parts and rough material (inventories over $3000), circulars, electrotypes, special machinery and fixtures, and an established trade. Address Sipp Machine Company, Paterson, N. J.

For Sale—One Nash gas engine, 20 horsepower, two cylinder, for electric lighting, pumping or power; one Beaman & Smith horizontal boring mill; table 23 inches wide, 36 inches long; will bore 12 inches diameter, 24 inches long, and face 20 inches diameter; one 300 light J. B. Colt Co. acetylene gas apparatus. The above machines are in excellent condition, having been very little used. For further particulars and prices apply to Rider-Ericsson Engine Co., 35 Warren St., New York.

Talks With Our Readers

By the Sales Manager

We occasionally get a kick from some reader that there's too much advertising in the AMERICAN MACHINIST.

He doesn't realize that if it were not for the advertisements—if it weren't a fact that the readers *profited* by reading the advertisements—

The AMERICAN MACHINIST would cost him at least ten times what he now pays for it.

* * *

This reminds us of the following story that we heard of some time ago:

"What are you doing that for?" bluntly inquired a young man of his seat-mate, who was scrutinizing the advertising pages of the magazine he had just bought. They were on a train bound for an afternoon's recreation. The older man was the president of a big corporation—about as busy a man as you could find.

"I'm just keeping in touch with the world," replied the corporation president. "I've tried a good many ways of doing it, but about the shortest cut I've found is to go through the advertising pages of the magazines—the good ones. Right there, for example, is the ad of a vacuum cleaner. It's one of the greatest of all modern inventions, so far as the home and the women are concerned. How did you find out that such a thing was in existence, that it had been perfected to the point of being commercially practical? Did you read it in the regular columns of a newspaper? Did you read an article about it in a magazine?"

"No," answered the young man. "I saw an advertisement of it in a household magazine—one my wife takes."

"You bet you did," responded the corporation president. "And you can say the same thing of nearly all the new things that make life more comfortable and pleasant. I call the advertising pages of a magazine its 'Progress of Civilization Department.' Once I heard a man complain because he bought a magazine that was 'half advertising.' It amused me, for it showed that he hadn't given the subject the first symptoms of a thought.

"'Man,' I said to him, 'don't you know that the more advertising a magazine carries and the more expensive that advertising is, the better its reading matter? Why? Because its advertising income must always regulate its editorial expense. You can't get away from that. The magazine that advertisers push and crowd each other to get in to has the money to spend for the highest quality in stories, articles, features, illustrations and editorial brains. Self interest will compel the publisher with the big advertising income to spend it that way too!'"

Then the young man asked:

"But how about the quality of the things advertised, as against those not advertised? I always had my doubts on that score."

"Oh, that's easy," replied the corporation president. "An advertising campaign these days costs big money—and the big profit to the advertiser is in creating permanent customers. That means he must back up his advertising with the right goods or else his advertising investment will not 'pay out.' The mere fact that a concern spends thousands to tell the people about its goods is an insurance on the quality of his goods. He gets their attention by his advertising; he must get confidence by the quality of the goods themselves—and, without that confidence, which makes them permanent customers or permanent consumers, his advertising expenditure is practically wasted. The man who advertises in an expensive medium has got to deliver the goods! And besides all that," continued the corporation president, "I've found out from practical experience that the advertising pages of the good magazines are mighty interesting reading."

* * *

Advertisements are the mile-posts in the march of commercial progress. Rip them out and you'd feel as if you'd been robbed of something live, snappy and up to date. It would be like walking down a business street that hadn't a sign or a show window to point the way or gladden the eye.

But the big point this keen observer made was this: Big advertisers have got to deliver the goods to make their investment "pay out" right!

* * *

Say you saw it in the American Machinist.

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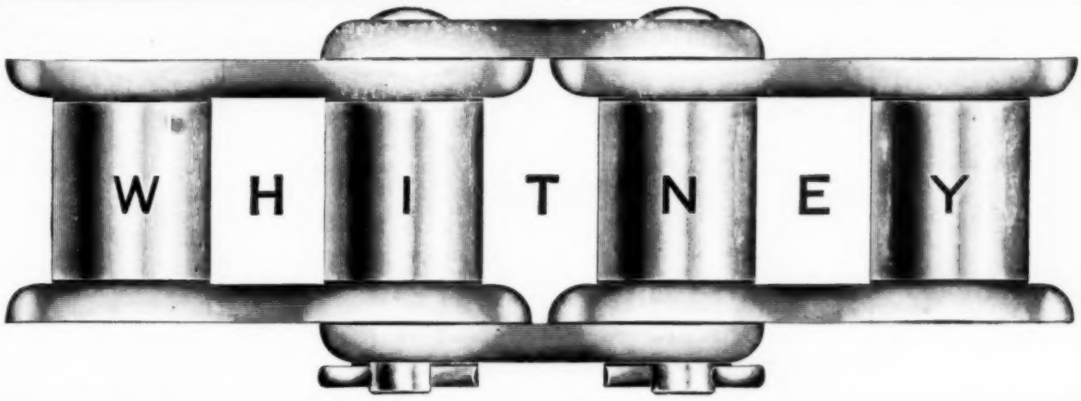
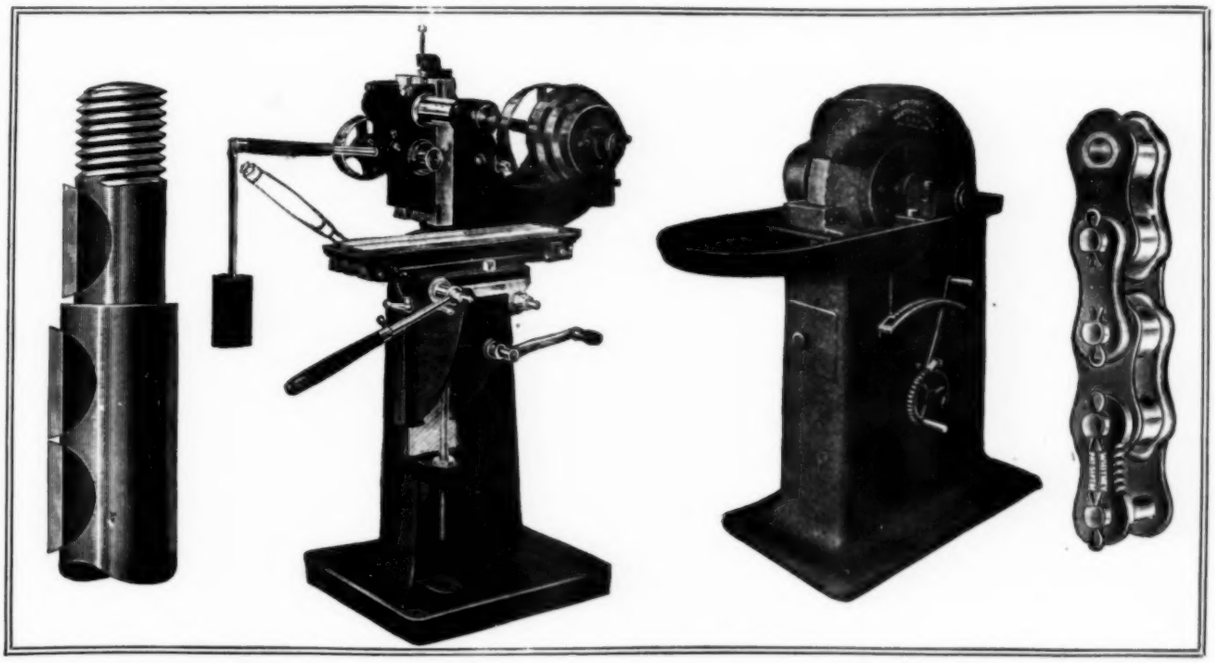


Chain Department

Roller Chains, Block Chains, Chain Belts, Quiet Chains, for Automobiles, Commercial Cars, Motorcycles, Bicycles, Machinery, etc.

Machine Department

Hand (feed) Milling Machines, 20-inch Water Tool Grinders, Keys and Cutters for the Woodruff Patent System of Keying, Presto Drill Chucks, Collets and Friction Tapping Devices.



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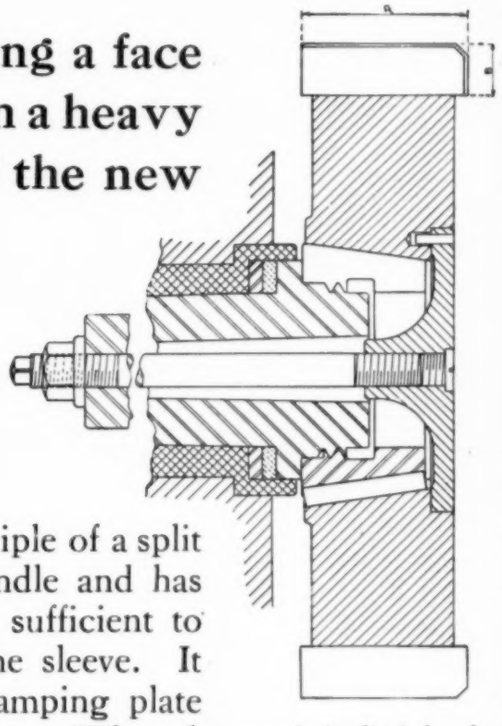
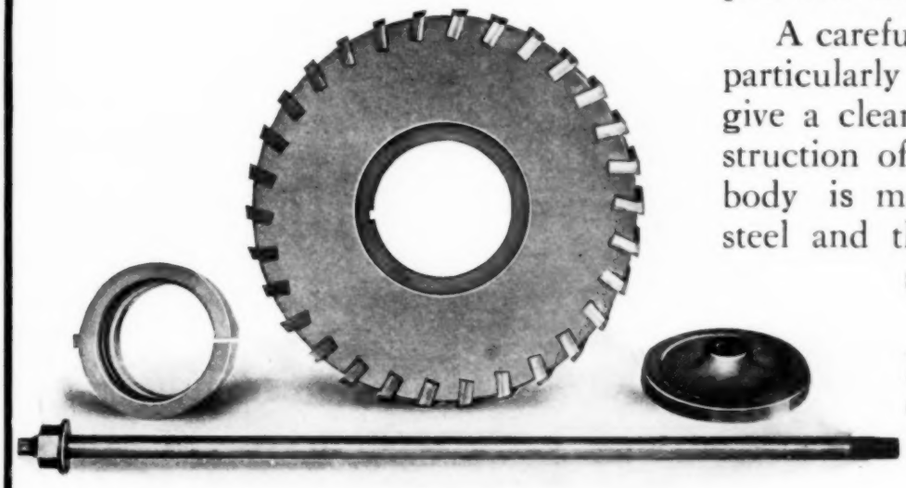
There is no difficulty removing a face milling cutter after it has taken a heavy cut provided that it is one of the new

B. & S. Inserted Tooth Face Milling Cutters



These cutters are designed on the principle of a split sleeve which screws on the nose of the spindle and has an outside taper. The cutter has a taper sufficient to cause ready release and fits the taper of the sleeve. It is drawn on to the sleeve by means of a clamping plate and drawing-in bolt and is held firmly in place. When the work is finished the drawing-in bolt is loosened and the cutter can be readily removed.

A further advantage is that these cutters allow for the transmission of the full power of the belt. With the old form of cutter it frequently occurs that the cutter becomes jammed on the nose of the spindle and can be removed only with the greatest difficulty. This cannot happen with the new cutters.



A careful study of the cuts, particularly the diagram, will give a clear idea of the construction of the cutter. The body is made of machinery steel and the blades of high-speed steel.

These cutters are listed in our 1910 Cutter List and in a special folder.

Write for them.

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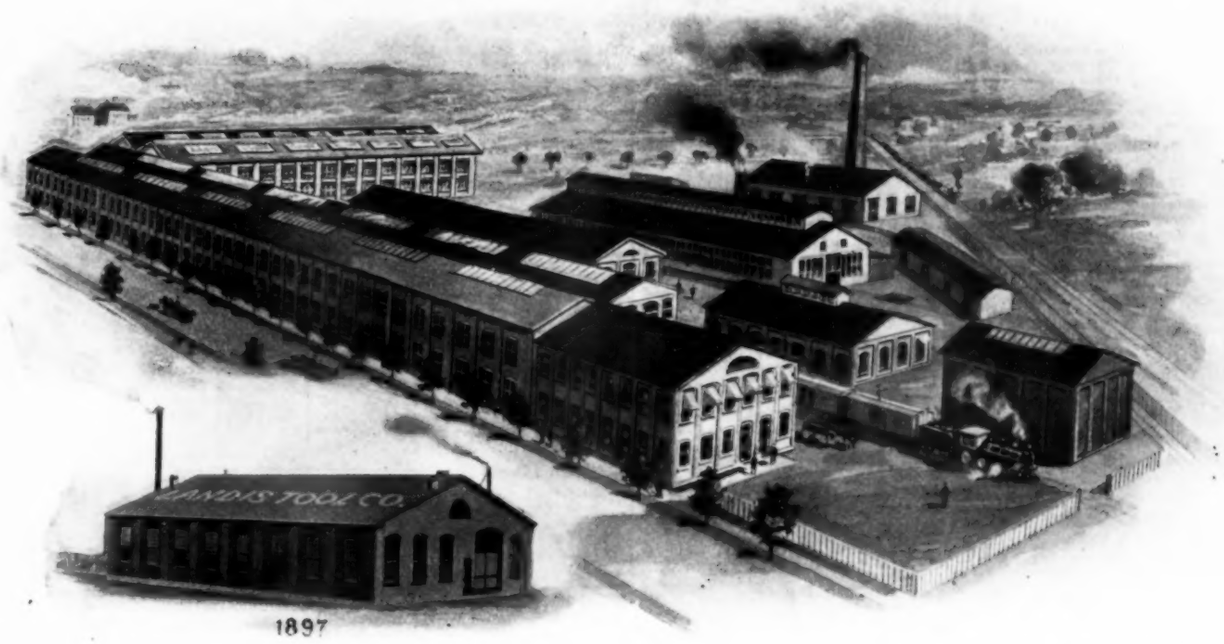


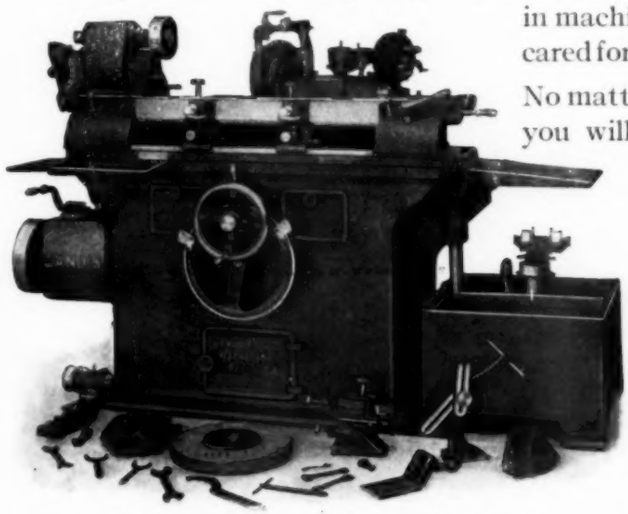
Birds-eye view of the Landis Tool Company plant, together with the company's first building in 1897

The Home Of The Landis Grinder

Note The Growth

THERE'S a reason for the great and steady growth of Landis Grinders. Any "Landis" user will explain it to you, or we will do so in detail if you ask us. Today, Landis Grinding Machines are looked upon as "Standard." They are used in all lines of machinery manufacturing and as now constructed are capable of producing finished pieces, whether accuracy is required or not, in less time than it can be done in any other way.

The arrangement of the various parts is such as to insure ease of manipulation, compactness and simplicity. They are easy of access, a feature much appreciated in machine tools, as it allows them to be properly cared for without unnecessary expenditure of time.



10x30 Landis Plain Grinding Machine

No matter what your grinding requirements are, you will be able to get economical, rapid and accurate results on a Landis.

We invite you to come and visit our plant. Write for Catalog "A."

Landis Tool Company,

Waynesboro, Pa.

New York Office, Fulton Bldg., 50 Church St., Walter H. Foster & Co., Managers.

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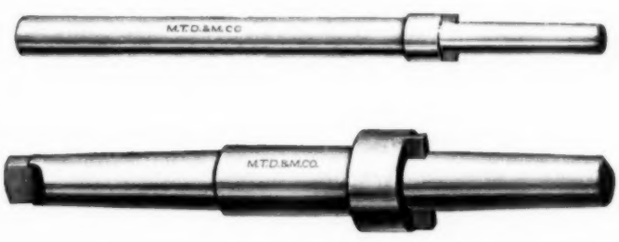

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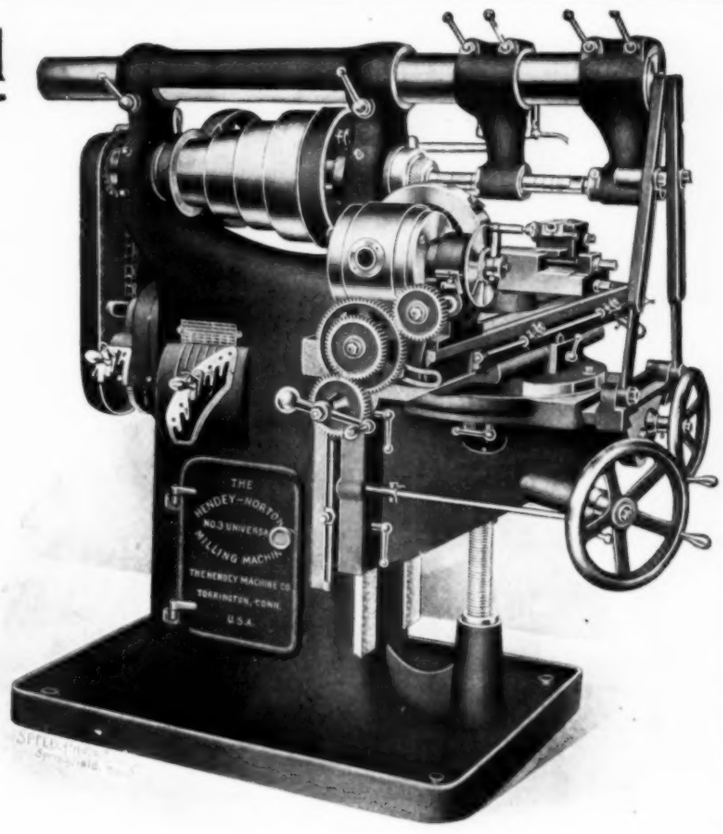

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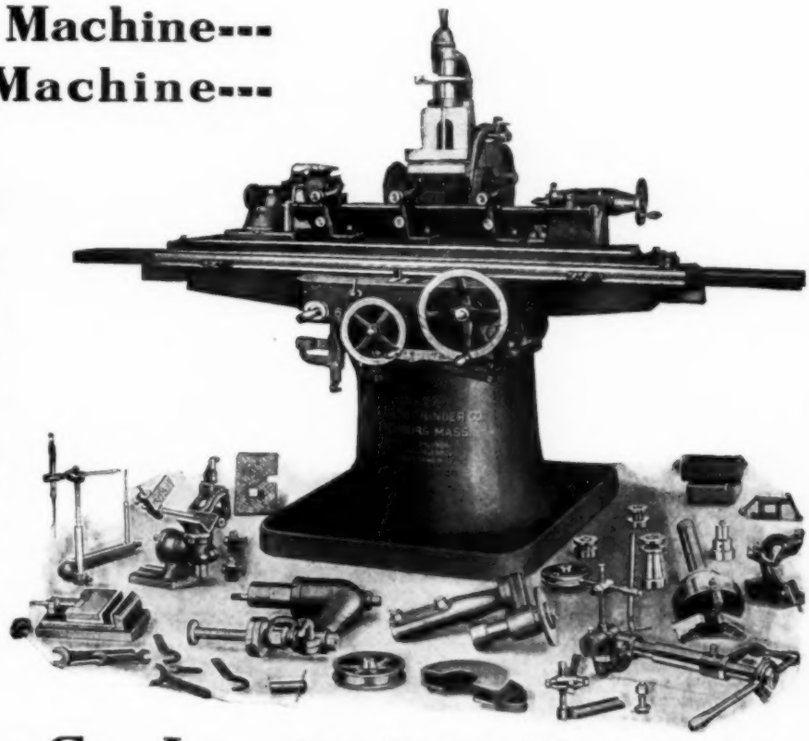

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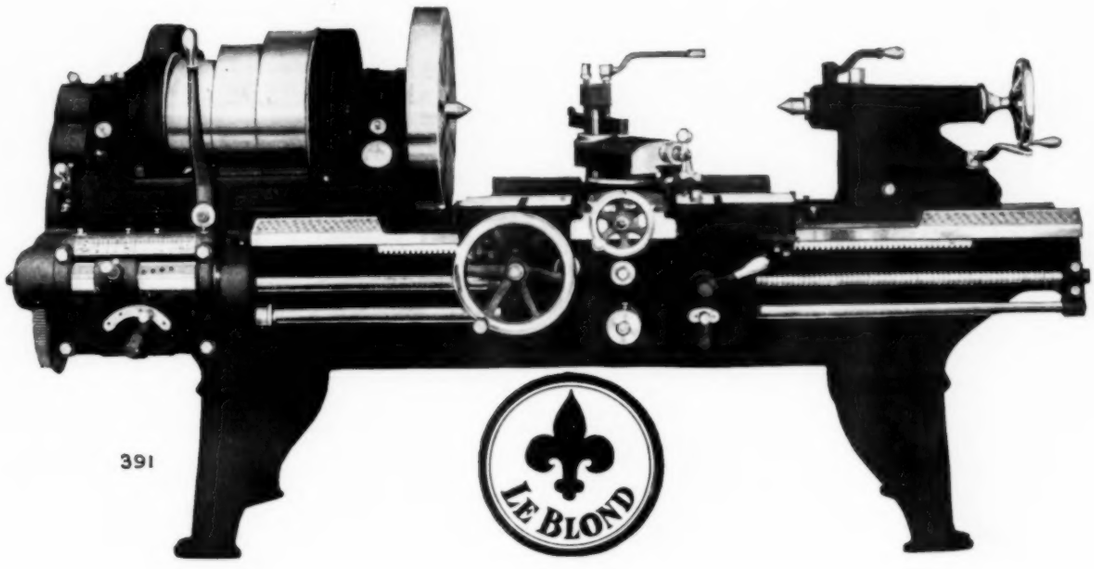

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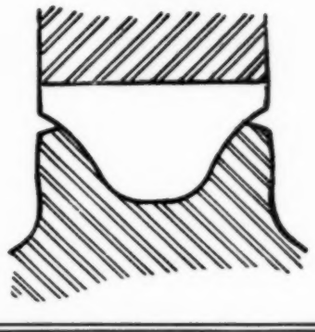

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